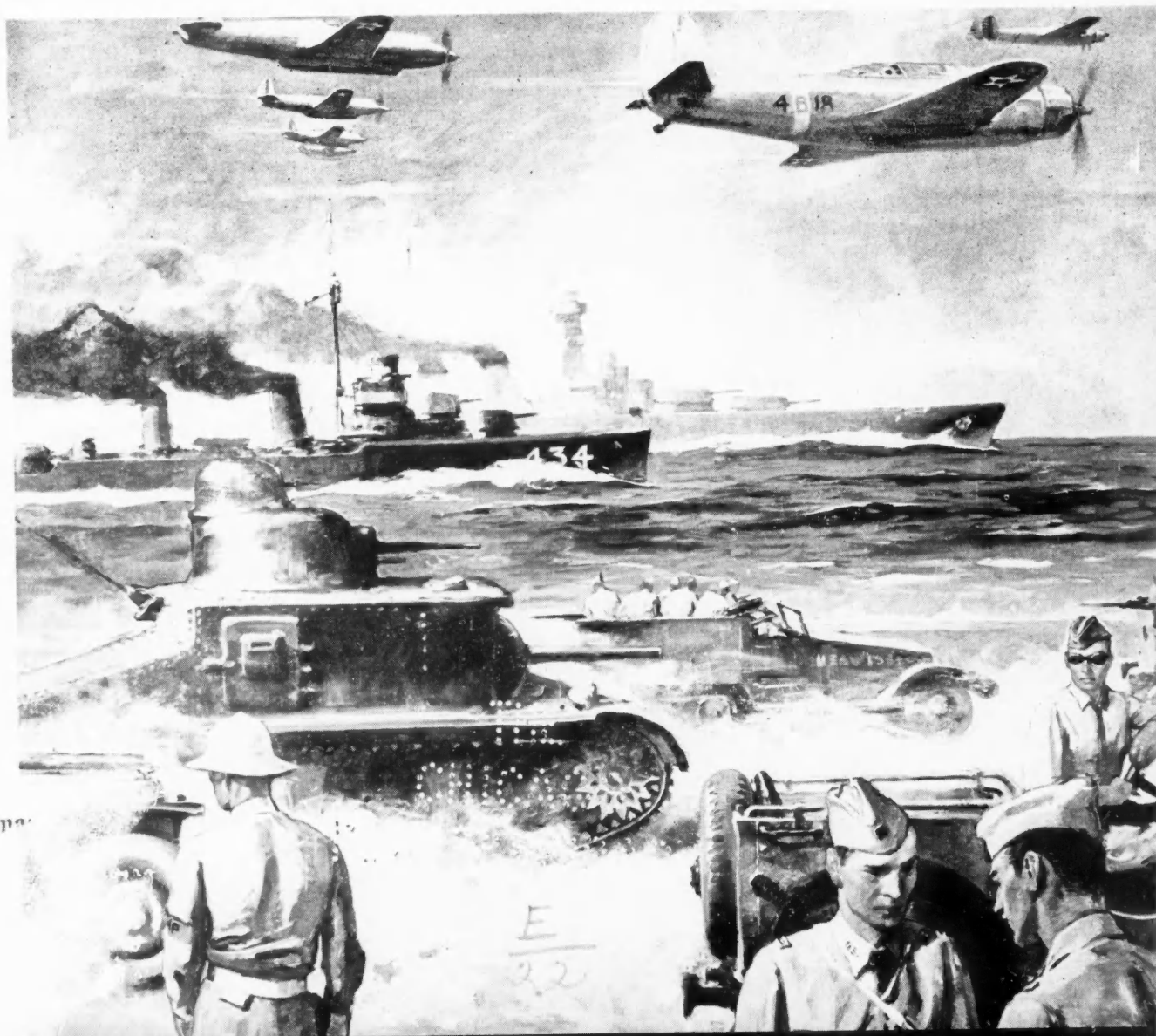


AUTOMOTIVE *and Aviation* INDUSTRIES

JANUARY 1, 1943



This man

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New Departure
THE FORGED STEEL BEARING

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STANICOOL H.D. SOLUBLE OIL

...to help you meet
more of your war-
born metal cutting
problems.

AGAIN the farsighted planning of Standard Cutting Oil Engineers has solved a machining problem which has been troubling many manufacturers with war production work. On certain operations, and with some metals, such as stainless steel, it is difficult to get good finish and tool life with a conventional water emulsion; yet a cutting oil will not supply sufficient cooling to prevent overheating of the tool and work.

By working with some of the first manufacturers who faced this problem, Standard's Engineers developed a cutting fluid that has both properties—the cooling quality of an emulsified oil and the ability to give tool life and finish approaching that obtained with a good cutting oil.

This oil, Stanicool Heavy Duty Soluble Oil, won't take the place of all other cutting oils, but it may be the solu-

Combines the cooling qualities
of a water emulsion
with the tool life and finish
approaching that
obtained with cutting oil.

tion to some of your troublesome machining operations. Two typical jobs it is doing are briefly outlined below.

If you have similar operations or problems, call in a Standard Cutting Oil Engineer. He can help you test Stanicool H.D. or some of the other new cutting oils recently developed for the new steels, new tools, and new operations on which you are now working. Write Standard Oil Company (Indiana), 910 South Michigan Avenue, Chicago, Illinois, for the Engineer nearest you.

TYPICAL STANICOOL H.D. SOLUBLE OIL JOBS



STAINLESS STEEL SCREW

Job. Machining 18-8 stainless steel from $\frac{7}{8}$ inch bar stock to size and shape of part illustrated.

Problem. Due to the extremely thin section of the screw head (approximately $\frac{1}{32}$), more cooling was needed than cutting oils could give. A conventional emulsified oil did not give satisfactory finish in facing the screw head.

Result. With Stanicool H.D., overheating and burning of the tool was eliminated. The special compounding in Stanicool, which gives it a heavy duty quality comparable to a cutting oil, gave satisfactory finish even though this stainless steel tends to tear or smear in machining.



HARDENED STEEL PART ON MACHINE GUN

Job. Drilling and reaming one inch holes in $\frac{1}{2}$ inch, 4340 hardened steel, machine gun part.

Problem. This would normally be a soluble oil job, but with a soluble oil the drills, striking hardened spots in the work, had to be reground after every 2 or 3 pieces.

Result. Sulfurized cutting oils and mixtures of various base oil blends with light mineral oil gave little improvement. Stanicool H.D. lengthened drill life from 2 to 3 to around 100 pieces per grind.

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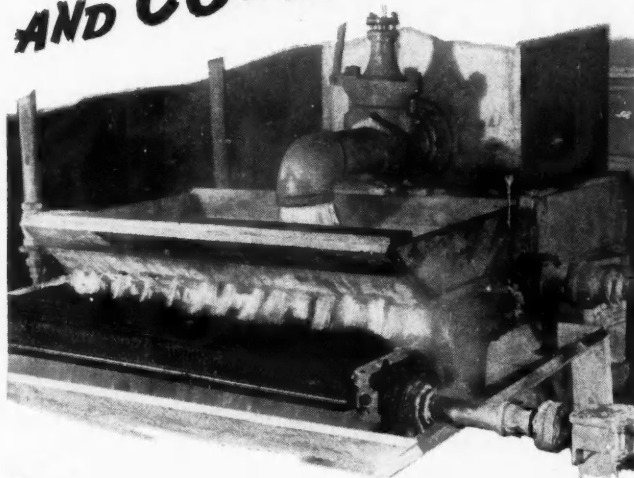
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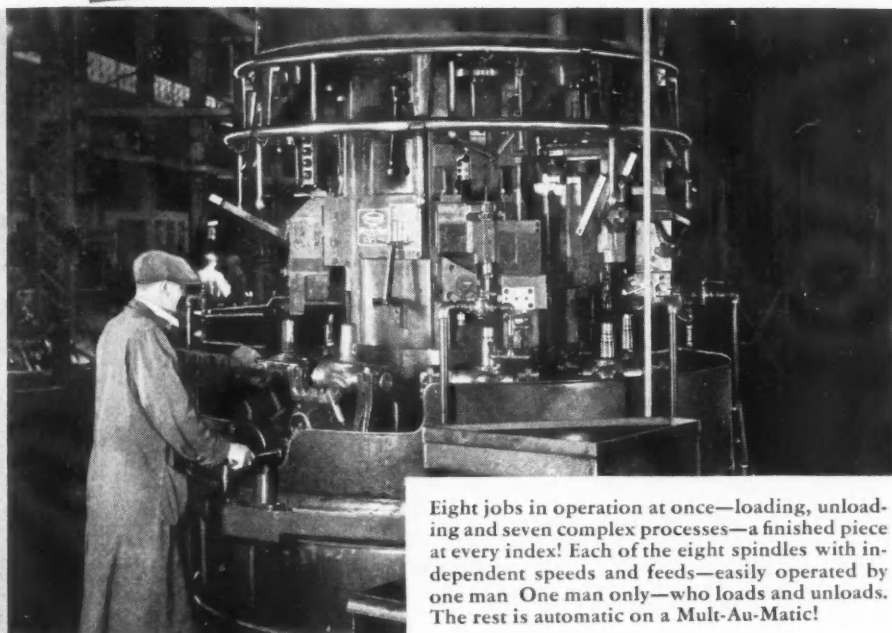
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AUTOMOTIVE and AVIATION INDUSTRIES

Volume 88 January 1, 1943 Number 1

**AUTOMOTIVE
INDUSTRIES**

Reg. U. S. Pat. Off.

Plan to Standardize Medium Tank Engines

Ordnance experts have been conducting extensive tests on proving grounds and on the actual battlefield for more than a year in an effort to simplify the type of engine used in medium tanks. Through the combined efforts of the automotive engineers and Army Ordnance experts, a decision has been reached on one engine which will be installed in the major portion of medium tanks, according to Brig. Gen. A. R. Glancy, deputy chief of Ordnance in charge of Tank-Automotive Center. "This does not mean," said General Glancy, "that this one type of engine will be used exclusively. The exigencies of warfare, and the demands of specific countries make it necessary to continue using other types for a limited number of medium tanks."

The use of diversified engines in the manufacture of tanks up to the present time has been caused by the necessity of the Ordnance Department to obtain quickly, maximum production of tanks by the use of existing facilities.

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Get back of the Pay-Roll Savings Plan by encouraging employees to turn part of their earnings regularly into tanks and planes and guns through systematic purchase of

**U.S.
WAR BONDS**

\$3 Billion Saving

17

Economies in the war program are resulting from the mass production methods of the automobile industry that are mounting to very sizable savings. These are being passed back to the government in hard cash. This article tells the whole story and there are some real surprises in it.

Quality Control Plays a Major Role at Bendix

18

This company has pioneered in the development and manufacture of landing gear for airplanes. The author goes into the details of design and the intricacies of making, to give a vivid picture of the outstanding accomplishments of this organization. The article is liberally illustrated.

Conservation of Critical Materials

26

In this war of production, cooperation has come from all directions to make the least go the farthest. What is being done and what it has accomplished is making real history. Read this account.

Redesign of a 40-Mm Gun Carriage for Welding

30

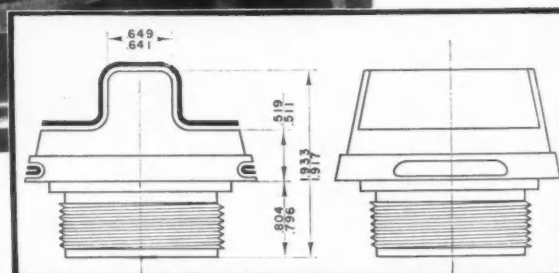
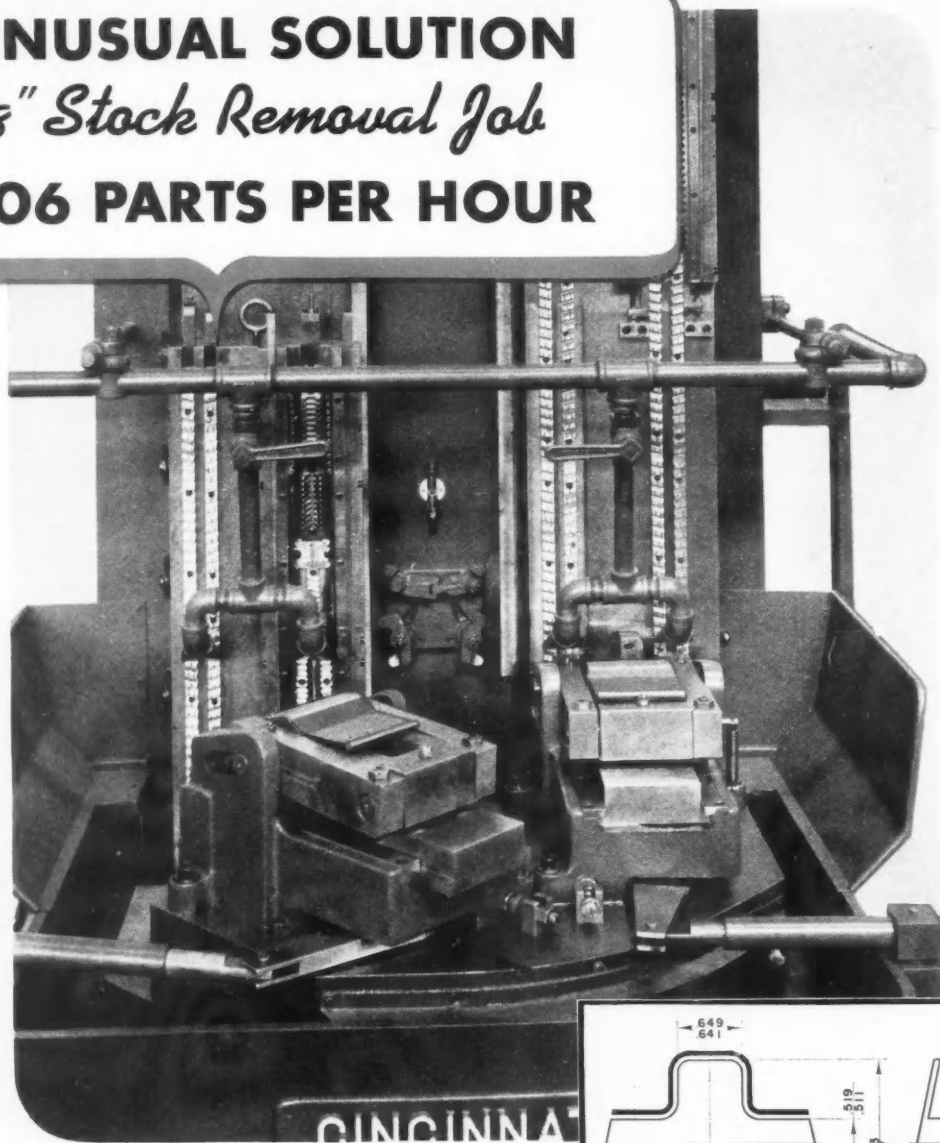
Europeans often have noted that "things are different in the United States" and again this proved true when the 40-mm gun carriage of European design was redesigned for manufacture in this country. Not only were they turned out faster but had many advantages over the bolted and riveted construction of the European makers.

Flight Performance Recorded Automatically

38

A new technique has been developed in the testing of airplanes in flight at the Vultee plant. Through radio it gives a ground crew of engineers an opportunity to watch every detail of performance and strain that is taking place in the plane under test. You should make this a "must read."

THIS UNUSUAL SOLUTION
of a $\frac{5}{8}$ " Stock Removal Job
NETS 306 PARTS PER HOUR



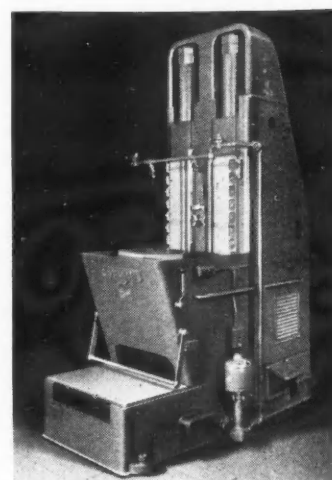
QUITE often, machine tools have the capacity to perform unusual operations . . . reaching beyond the commonplace, run-of-mine job. Today, this trait is more worthy than ever before, as production may often be attained by disregarding established procedure.

Broaching machines, for example, ordinarily remove up to $\frac{5}{32}$ " stock. Greater amounts are within the field of other types of machines. Nevertheless, the equipment illustrated above — a CINCINNATI No. 10-66 Vertical Duplex Hydro-Broaching Machine — removes about *four times* as much as the conventional stock allowance while producing at a rapid rate.

This machine broaches the tang and two wrench slots on fuse bodies, removing about $\frac{5}{8}$ " stock, at the rate of 306 per hour.

Two parts are held in each fixture. The total depth of cut is obtained progressively, transferring the part from one side of the fixture, where it has been roughed, to the other side of the fixture, where it is finished. This arrangement produces one finished part each stroke of each ram (two parts per machine cycle).

Perhaps many parts in your shop could be completed more rapidly by the broaching process. Our engineers will be glad to give you their recommendations.



● CINCINNATI No. 5-42 Duplex Hydro-Broach Machine. Write for catalog M-894. See our catalog in Sweet's.

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POOL ROOM AND MANUFACTURING MILLING MACHINES... SURFACE BROACHING MACHINES... DIE SINKING MACHINES

Automotive Industry Passes Along

\$3 Billion Saving

To Government

COST savings to the government through application of the automotive industry's mass production techniques to the manufacture of armaments are estimated at more than \$3 billion. This saving will average about 15 per cent on the industry's total orders of nearly \$19 billion, as contract revisions and renegotiations are going on constantly between the automotive companies and the government procurement agencies. Economies in per unit tooling, labor and overhead costs resulting from volume output are being passed along continually to the government in the form of price reductions. Only threats to further reductions in war product costs are higher wage rates, which are theoretically stabilized at the Sept. 15 level by presidential decree, high raw material prices or radical design changes that may interrupt production and necessitate some retooling.

Many armaments such as guns, tanks and airplanes had not been produced in any considerable volume in this country since the last World War and of course the designs of that period generally were outmoded. When automotive companies submitted bids on these orders, they had to make their cost estimates on the basis of government arsenal records or foreign production prices based on small volume—a virtual hand-built product.

Donald M. Nelson, chairman of WPB, recognized this situation last April when he set up the Price Adjustment Board of WPB to review contracts in order to work out adjustments or refunds to the government where costs or profits were found to be excessive.

"The fact that such savings can be made is simply a reflection of the fact that neither profits nor costs can be accurately figured in advance in time of war," said Nelson. "In our war program we are calling on industrial firms to manufacture hundreds of articles which were never previously made on a mass production basis. In most cases the articles are being produced in previously unheard-of quantities. It is perfectly obvious that as a company gets into

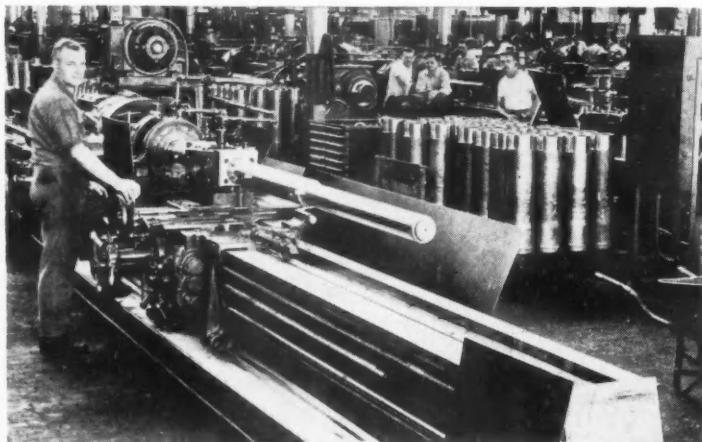
mass production on such articles, its costs go down. It costs less per gun to make 20,000 machine guns, for instance, than to make 100. It is also obvious that it is not possible for a new contractor to know in advance just how much these costs are going to drop. It is also true that the primary objective of the procurement officers must be speed in production. Hence it is out of the question to delay signing of all war contracts until everyone is certain that costs and profits have been figured down to the most just and equitable level. As production gets into full swing, both the contractor and the government get a clearer picture of costs and are able to determine what constitutes a fair profit."

Price reductions and cash refunds totaling \$829,332,800 have resulted from renegotiation on its contracts in the seven months ending Dec. 1, according to the War Dept., and the figure was expected to reach \$1 billion by Jan. 1, 1943. Cash refunds effected by the Price Adjustment Board and other War Dept. agencies up to Dec. 1 totaled \$124,220,400 while price reductions in the same period totaled \$705,112,000. Noting a growing appreciation among contractors of the value of the renegotiation statute, Maurice Karker, chairman of the War Dept. Price Adjustment Board, said recently, "Almost without exception the board has found that manufacturers welcome the opportunity offered by the renegotiation statute to readjust their profits on war contracts since American industry has no desire to profiteer."

A war product whose price has been progressively reduced through volume output is the 50-caliber Browning machine gun made by two divisions of General Motors Corp. Based on the records of other manufacturers, GM agreed on an original price of \$967 per gun when the contract was consummated in Sept. 1940. Soon this was reduced successively to \$892, \$590, and \$496, with three-fifths of the contract delivered at the latter price or lower. This marked a saving of nearly 50 per cent on the
(Turn to page 52, please)

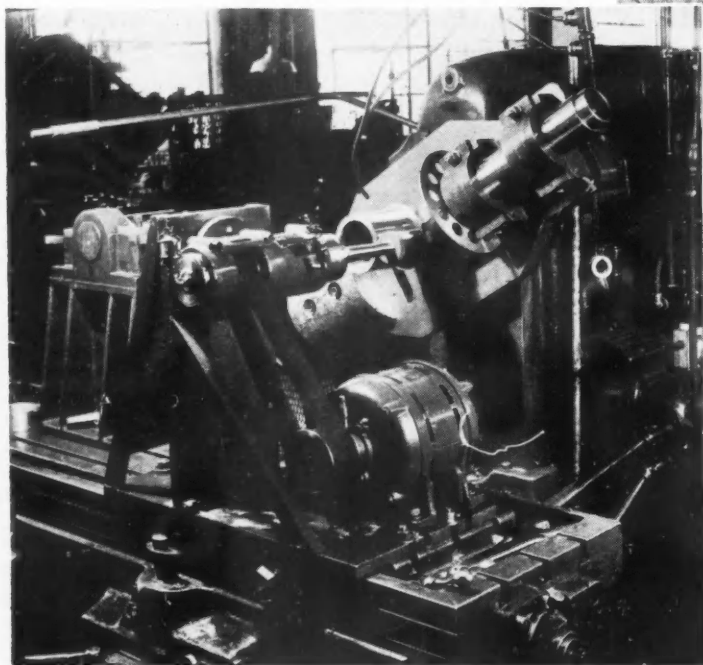
Quality Control Plays a

By Joseph Geschelin

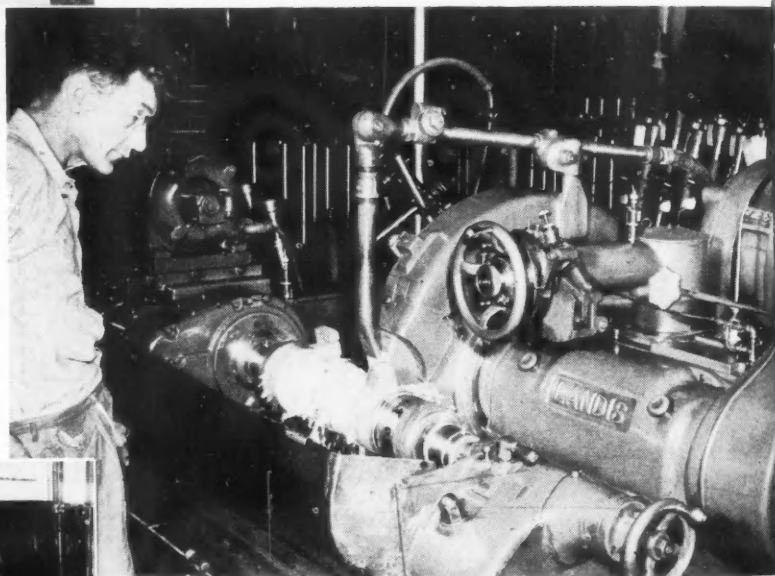


(Above) Boring of large cylinders is done on a huge Gisholt turret lathe in the Bendix Division. Note the long bed and unusually long boring bars required to handle bores exceeding 25 in. in length.

(Below) Parent plant, designed for job-lot production of large strut assemblies, is replete with improvised set-up. One of the most ingenious of these is this big Cincinnati milling machine, converted by the addition of individual spindle drives, to handle the turning and grinding of socket end of a large axle. The work-holding fixture in this view is typical of the massiveness required for precision work.



PIONEER in the field of airplane landing gear development and manufacture, Bendix Aviation Corp. boasts a background stemming from J. R. Cautley's initial experimental projects in 1925. The art of cushioning extraordinarily heavy impact loads is old, having a history of at least 50 years, its best expression being found in the recoil mechanism for heavy artillery. Under Mr. Cautley's direction the Bendix contribution has consisted in the investigation of the best known methods, the adoption of a specific principle, and finally the development of the Bendix principle in accordance with most modern engineering methods, and economical manufacturing procedures.



(Above) Here is one of the Landis external grinders, part of a large battery in the Bendix Division plant.

Currently Bendix is producing many different sizes and numerous types of landing gears. The parent plant has the unique distinction of being both a manufacturing organization with complete facilities for producing the entire gamut of struts in the program; and a development center for the conception of new and improved designs and for the establishment of suitable production procedures.

One of the most valuable contributions of

ys a Major Role at *Bendix*

the latter function is that of "Technical Assistance." Specifically, this is concerned with the establishment of sub-contracting sources all over the country—supplying production drawings and specifications, providing engineering and research information, and assisting in the establishment of production techniques.

As a corollary to this form of organization, the present plant is essentially an extremely flexible manufacturing set-up capable of handling all of the vari-

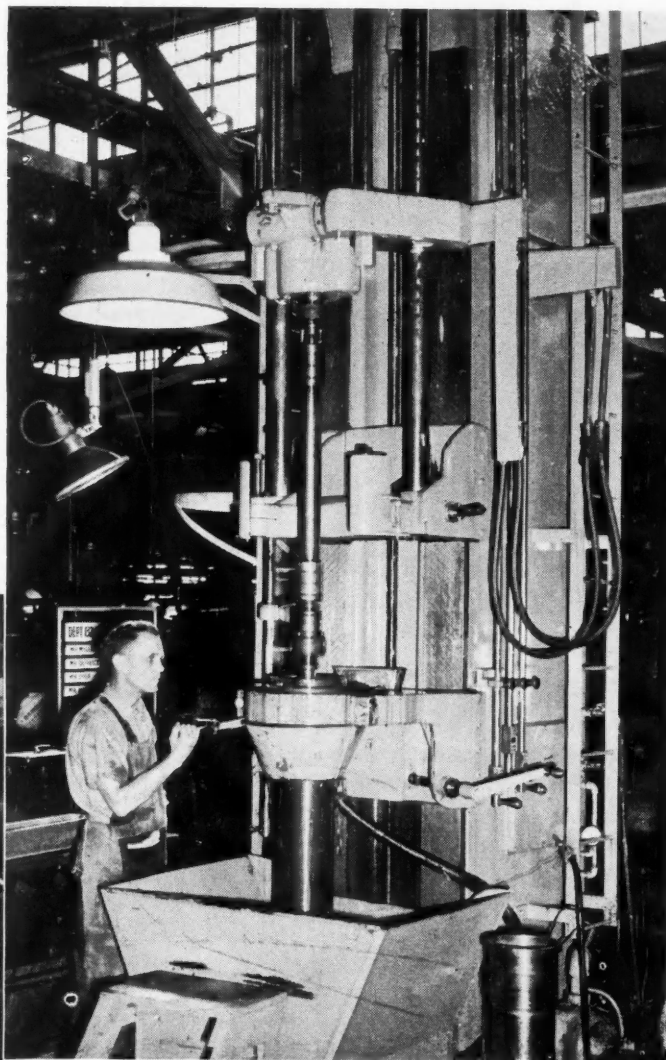
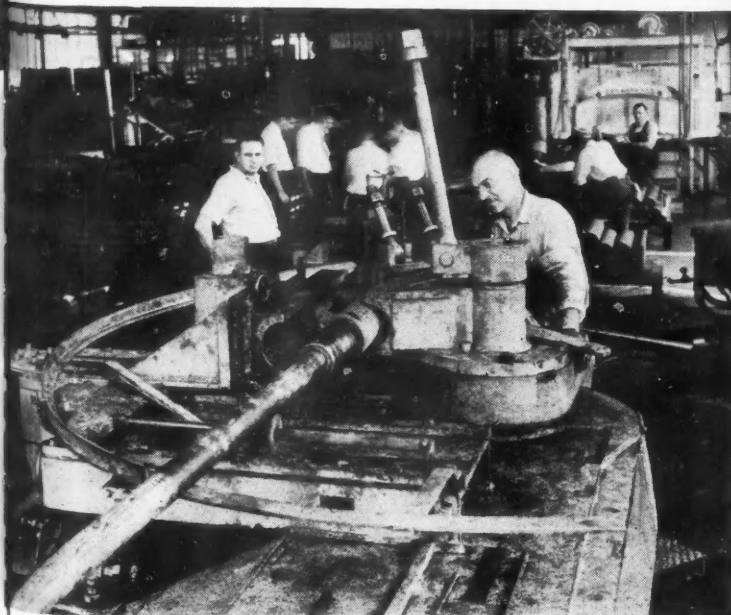
eties of landing struts on what may be termed a job-lot basis. The function of the sub-contractors is to establish more or less mass-production facilities for handling only a few varieties of those designs that involve large production quantities.

In this article, we shall confine ourselves to a high-spotting of the flexible manufacturing set-up of the parent plant; and of the mass-production set-up in the Bendix Division in Michigan.

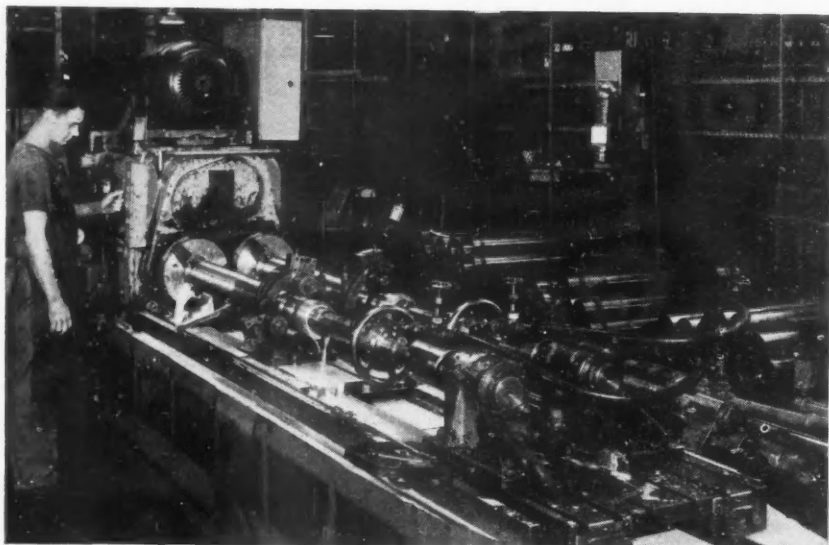
Before we touch upon the sampling of production techniques, it is of interest to examine the nature of the problems involved. According to Mr. Cautley, landing strut manufacture is perhaps one of the most

*This is the Seventy-seventh
in the series of monthly
production features*

(Below) Large bent tube sections running upwards of 8 in. in O.D., are formed cold on this unusual power bending machine installed in the parent plant. Outer end of the tube is held true by means of the reciprocating mandrel attached to the bar at the left. Accuracy of the bending operation is held to 10 minutes of the arc.

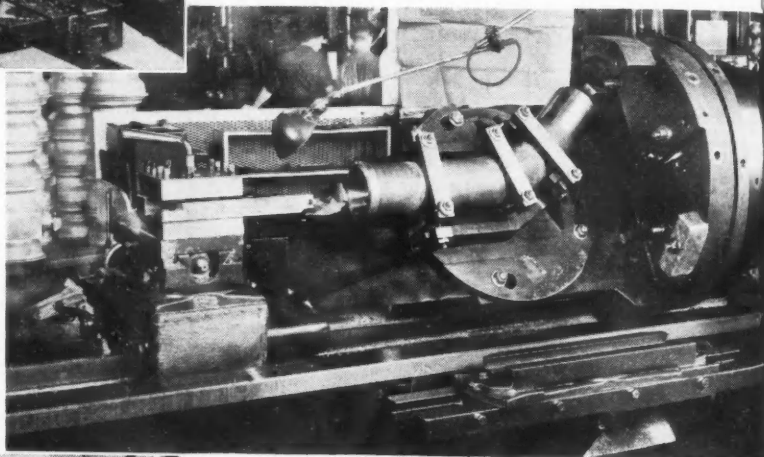


(Above) Among the largest of the Barnes Drill Co. honing machines to be found in the automotive industry is this unit, used for honing the large cylinders at the parent plant. Micromatic hones are employed.



(Left) W. F. & John Barnes two-spindle horizontal boring machine speeds up the boring of long cylinders (parent plant).

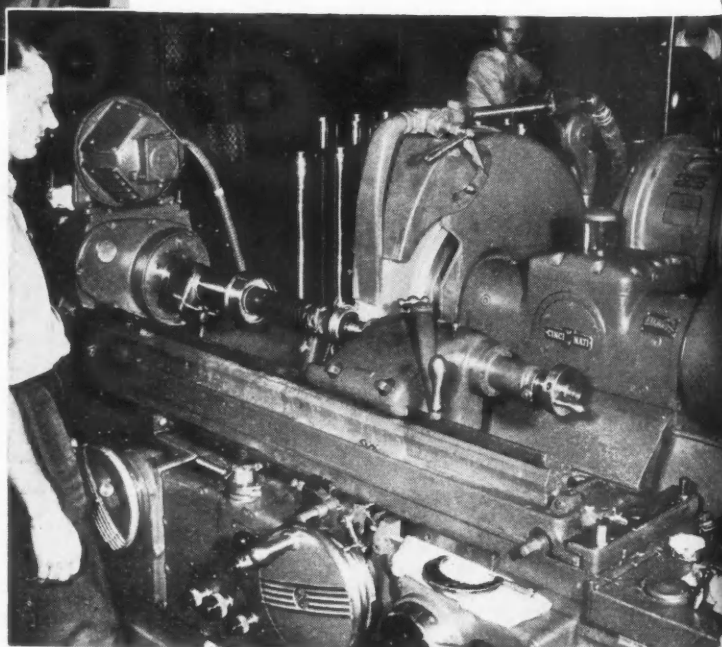
(Below) This huge Libby lathe is typical of the heavy duty equipment in the parent plant. The illustration emphasizes the specialized techniques developed here for the turning and boring of large bent sections. Attention is drawn to the massive work-holding fixture; method of holding the work; and the heavy cemented-carbide-tipped cutting tool used for boring.



(Below) Lincoln Electric Co. shielded-arc welders are employed both at the parent plant and at the division plant. Here is the interior of one of the many welding booths at the Bendix Division. The Lincoln welder is at the extreme right. Note the massive steel fixture in which the work is held.



(Below) Cincinnati Filmatic cylindrical grinder in the Bendix division plant set up for grinding an inner cylinder assembly.



costly operations in the airplane field. To appreciate the full import of this statement, consider some of the major elements of the problem.

Take the utilization of materials. Starting with a rough forging, chip removal is so extensive that on the average the weight of the finished part runs as low as 15 per cent of rough weight and in most instances does not exceed 1/3 of the rough weight. CHIPS, therefore, represent a major part of the production cost.

When it comes to chip removal consider that the forgings are machined in heat-treated condition except in the roughing stages. Most of the major parts are of chromium-moly alloy steel developing a hardness of 39 to 41 Rockwell C-scale, corresponding to around 362 Brinell, on the average.

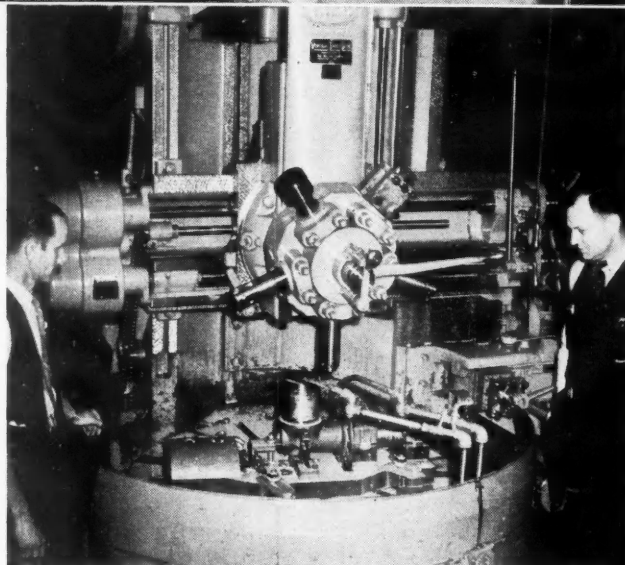
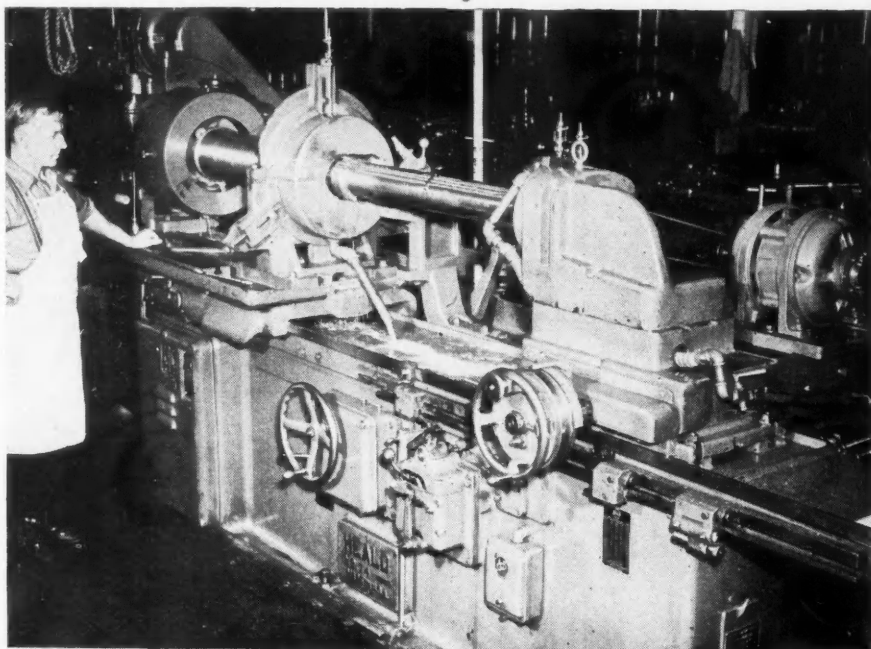
Internal grinding of cylinder bores is done on large Heald machines, of which this No. 74 grinder is a good example (Bendix Division). Bores are held to within plus or minus 0.001 in. for a length of about 25 in.

The high order of chip removal combined with the requirements of fine dimensional tolerances and exceptionally close tolerances on concentricity and alignment, demand large massive machine tools of most modern design, requires the development of heavy jigs and fixtures capable of holding the work in precise alignment.

Fortunately one of the aspects of heavy chip removal is completely satisfied by the extensive use of steel cutting grade cemented-carbide single-point cutting tools. Carboloy is employed on practically every metal cutting operation and appears to have solved the problem of cutting heat treated steel to perfection. Here again it may be appreciated that the most economical utilization of Carboloy, with its requirements of higher speeds, heavier cuts, and complete freedom from chatter or vibration is satisfied only by the use of massive work-holding devices and oversized machine tools having adequate power and rigidity.

Quality control plays a major role in the Bendix operation. It begins with raw materials—forgings and tubing. These are produced to special analysis with close control of the chemistry of the steel. Indeed, this is so critical that Bendix requires a formal chemical analysis of each mill heat.

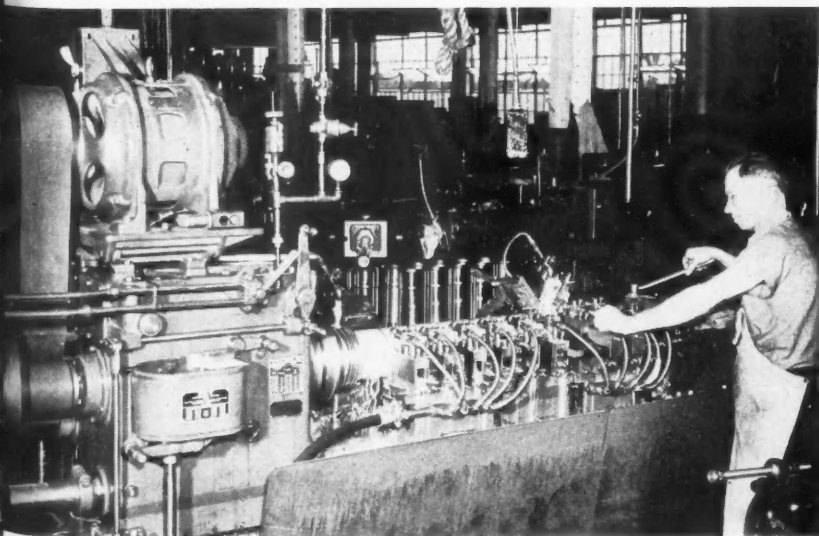
Next consider manufacturing control. Not only is it necessary to maintain close tolerances

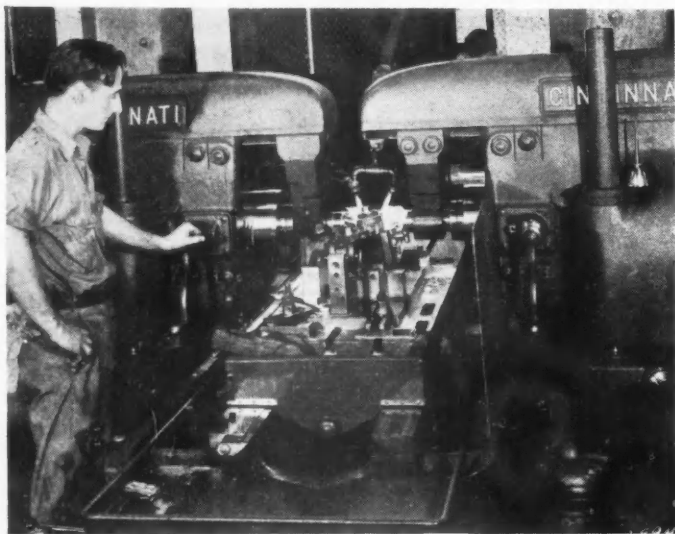


Bullard V-T-L, one of a battery in the parent plant—boring, facing, and turning socket end of axle forging.

on the dimensions and alignment of each individual component; it is also imperative to hold the summation of these tolerances to a specific limit for the entire assembly. While some strut assemblies are small—not much larger than a bus-type shock absorber—the majority range from 6 ft to as much as 8 ft over-all, include bent members and from five to seven jointed sections. Yet the over-all tolerance on the longest strut assembly must be held to plus or minus 1/16 in., while the angularity of the axle mem-

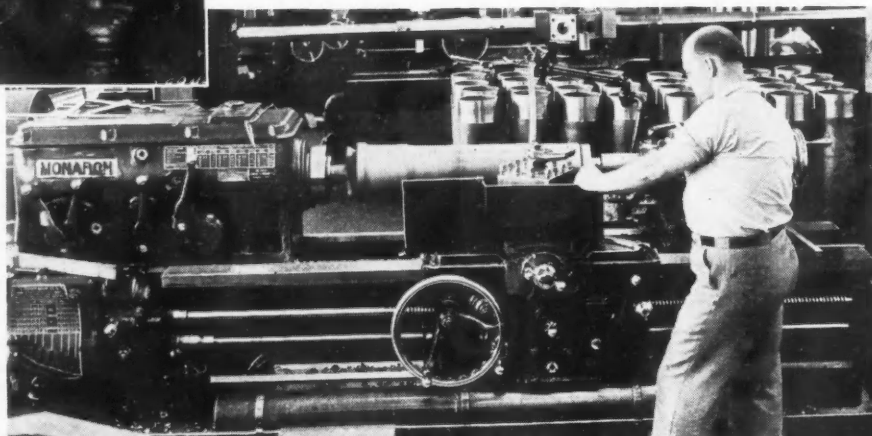
One of the most spectacular operations is the turning of big outer cylinders on this large Fay automatic lathe. Note the array of tool blocks, front and back, fitted with single-point cutting tools tipped with cemented-carbide of steel cutting grade (Bendix Division).



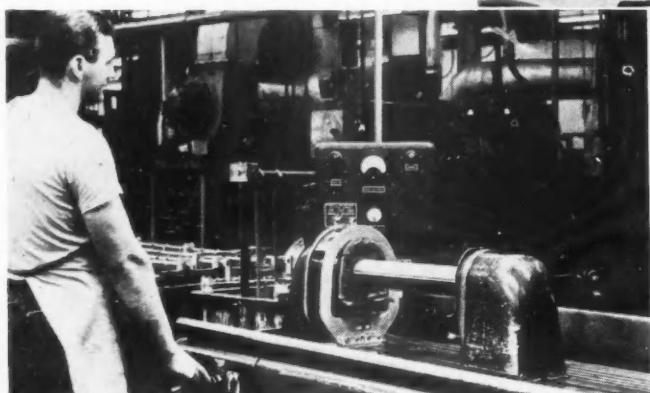


(Left) Duplex milling machine set-up consisting of two Cincinnati millers serving a single table. Flexible arrangement permitting separate operations requiring different speeds; also providing great power capacity (parent plant).

(Below) View of one of the heavy duty Monarch lathes used for turning the O.D. of big cylinders (Bendix Division).

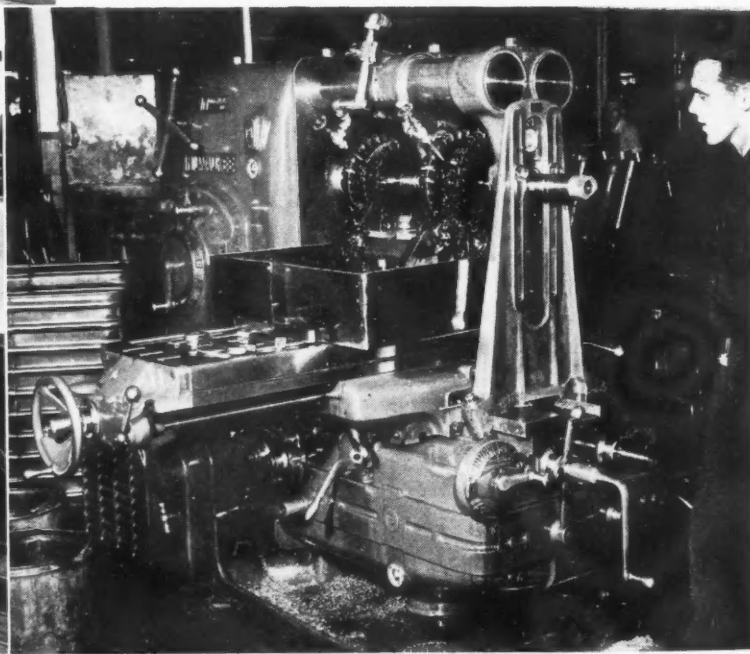
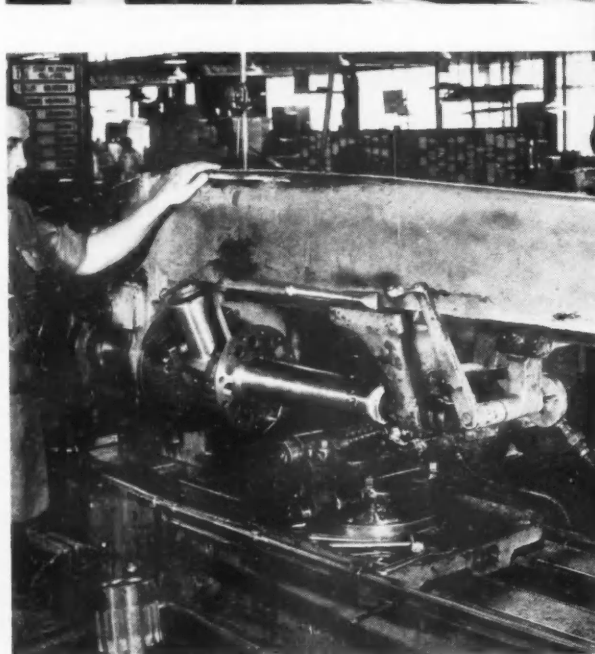


(Below) All cylinders and forging elements are inspected for surface perfection on Magnaflux machines, such as this one in the Bendix Division plant.



(Lower left) Rugged Barber-Colman hobbing machines are found in the parent plant. This one is cutting splines on the end of the Axle for a large strut assembly.

(Below) Example of heavy duty milling on strut forgings is this Model K Milwaukee mill at the Bendix division plant. Attention is drawn to the arrangement of heavy milling cutters, tipped with cemented-carbide. Ruggedness of these milling machines contributes to freedom from chatter and vibration, thus producing extreme accuracy.



ber at one end must be held within 10 to 20 min in axial relationship with the vertical member at the other end.

Moreover, the total weight of the assembly must be maintained within plus or minus 1 per cent of specified weight. And this despite the fact that the contour of forgings is not machined as it is in the case of rotating airplane engine parts.

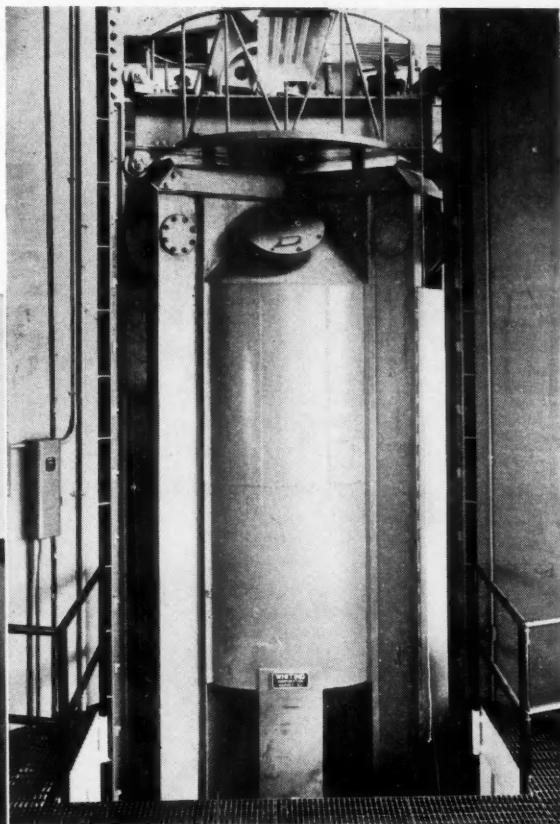
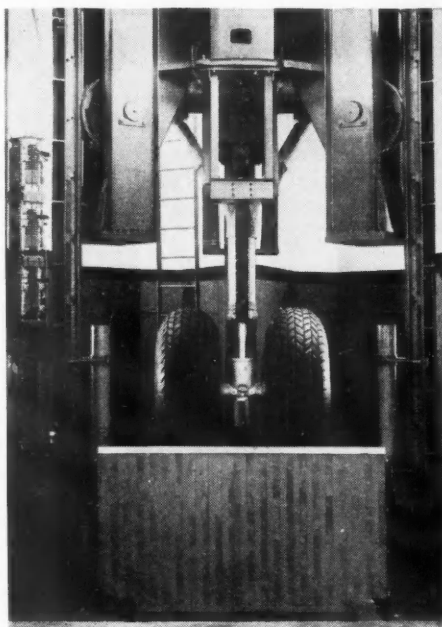
Dimensional tolerances on strut members have unique character. They are not as fine, when expressed numerically, as are the tolerances on the general run of aircraft parts. But they are extremely close when considered in the light of an over-all specification. In explanation of this paradoxical statement, take one general example. Take just one of the cylinders. Here is an internal grinding operation in which a bore of $6\frac{3}{4}$ in. is held to plus or minus 0.001 in. Now a tolerance of 0.001 in. is not considered as being very fussy. But when it must be held in a bore $25\frac{1}{2}$ in. in length with true concentricity, that becomes a serious problem. In the same fashion, tubes of $7\frac{1}{4}$ in. I.D. are ground to the same tolerances for a length of 25 in., the wall thickness being but $\frac{3}{16}$ in.

Here is another example of a different kind. Certain tubular members are bent to form in a special bending machine at the main plant. A tube of say 6 in. in diameter is so bent that even on this rough operation the axial alignment of the tube ends must be held to within plus or minus 10 min of the specified arc.

Perhaps one of the most impressive features of the research facilities in the parent plant is the big building devoted to drop testing of experimental and production assemblies. Back in 1929 the most severe drop test was one in which the impact load was of the order of 5000 lb. Today, a small Bendix testing machine can drop a weight of 30,000 lb while the new giant machine—probably one of the largest in the world—handles a normal load of 130,000 lb and can be employed for the testing of struts for the heaviest ships built in this country.

As mentioned earlier, the manufacturing operation in the parent plant is extremely flexible, employs massive machine tools capable of handling a wide variety of parts over the same lines. This is evident from the

Development of landing gear assemblies stems from research work with this mammoth Whiting drop testing machine. Said to be largest in the world, this machine can handle struts for largest airplanes built in this country.



statement that the plant is producing many different strut assemblies mostly in moderate or in small lots.

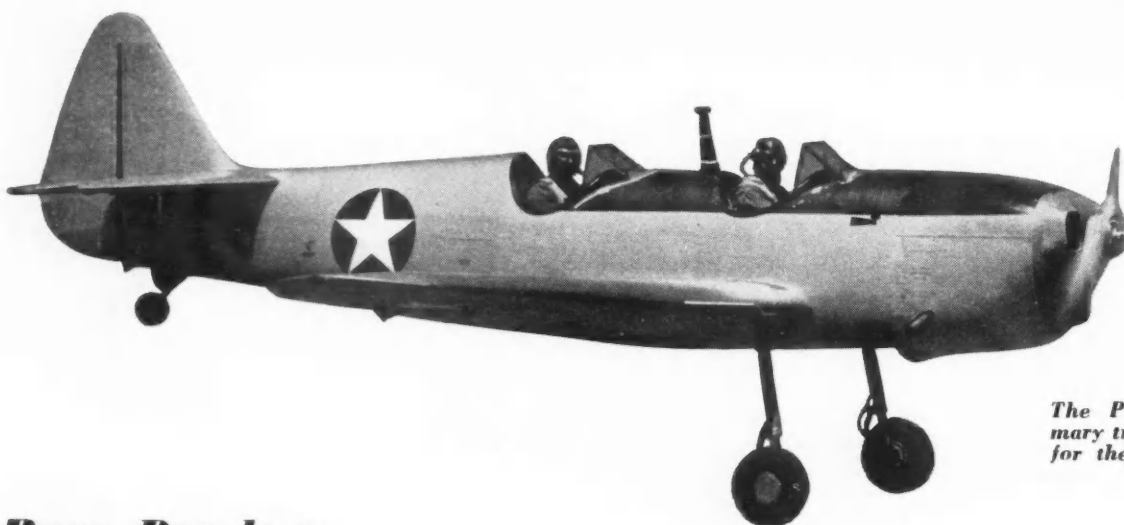
Among the machinery in this plant will be found—Fay automatic lathes, Cincinnati vertical, horizontal, and duplex milling machines, Cincinnati grinders, Milwaukee mills of various types, Monarch lathes, Libby lathes, Heald internal grinders of the largest sizes made today, Gisholt turret lathes, Barber-Colman hobbing machines, Baker heavy-duty drill presses, Natco multiple drills, Lees-Bradner thread millers, several large W. F. & John Barnes horizontal two-spindle boring machines, etc.

In addition, the parent plant has a separate building housing the huge tube bending machine and an extensive heat treating department. The many heavy-duty welding operations are handled in separate booths fitted with Lincoln shielded-arc welders.

Even a cursory examination of the machine shop set-up brings to light many ingenious jigs and fixtures designed to simplify the operation and to assure precise alignment. Naturally these fixtures are massive and rigid and are among the largest to be found in machine shops in the automotive area. Some examples of this will be noted in the pictorial section.

Too, attention is drawn to the ingenious work-holding arrangement employed for the turning and boring of the bent tubular members. This is particularly striking in the set-ups found in the parent plant where all of these members are formed.

Machine shop operations in the parent plant are
(Turn to page 44, please)



The PT-25 plywood primary trainer built by Ryan for the Army Air Forces.

Ryan Develops

Plywood Primary Trainer fo

RYAN AERONAUTICAL CORP. has completed a plywood trainer for the U. S. Army and also has started to build scout observation planes for the Navy. The Ryan ST-4 training plane, which bears the Army Air Force's designation PT-25, is entirely new in design, construction and materials, the development having been undertaken to eliminate aluminum alloys and other strategic materials, which was accomplished with the exception of the engine cowling that represents less than two per cent of the total weight of the plane. No forgings, castings or extrusions are used in the ST-4 trainer, nor are any of the fittings or structural parts made of critical steels.

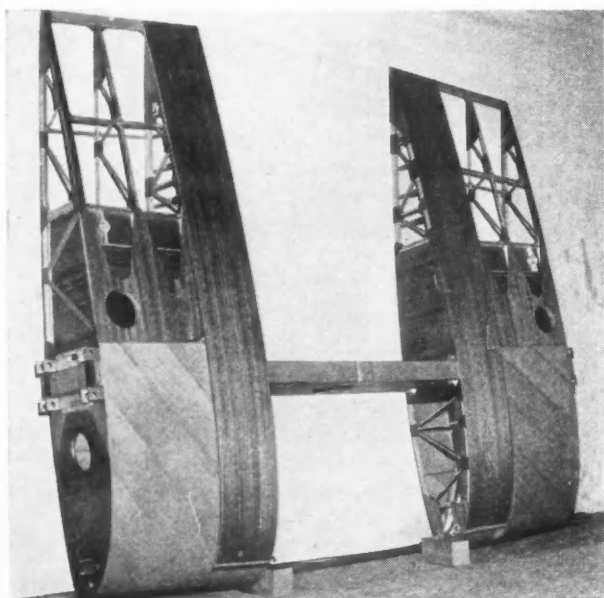
The scout observation plane placed in production by Ryan is the basic type developed for the Navy Bureau

West Coast Company also Producing Navy Scout Observation Planes

of Aeronautics by the Curtiss-Wright Corp., which has been producing them for some time at its new Columbus, Ohio, plant. It is known as the Seagull and the Curtiss model is the SO3C. The Ryan plane has been designated the SOR-1.

Intended for either ship- or land-based operation, the SOR-1 will be equipped with either wheel landing gear or floats, the latter installation consisting of one main float and two wing tip floats. It is powered by a Ranger 12-cylinder engine of the inverted-V, in-line, air-cooled type that develops over 500 hp. The all-metal fuselage is an aluminum alloy structure of the monocoque type and has a flush riveted aluminum alloy

(Turn to page 54, please)



Ryan St-4 (Pt-25) Weights, Dimensions and General Data

Weights and Loadings			
Oil (3 gal.)	23 lb	Fin Area	5.2 sq ft
Gasoline (27 gal.)	162 lb	Rudder Area	7.83 sq ft
Instructor	190 lb	Aileron Area	16.66 sq ft
Student	190 lb	Flap Area	7.07 sq ft
Gross Weight (Design)	1800 lb		
Power Loading	9.7 lb/hp	General Data	
Wing Loading	11.1 lb/sq ft	Wing Incidence (Root)	4 deg
		Wing Dihedral	5 deg
		Wing Sweepback (L.E.)	4 deg-03 min
		Wheel Tread	80 in.
		Tire Size	7:00 x 6
		Tail Wheel Size	8 in.
		Propeller Diameter	7 ft-2 in.
		Propeller Clearance—Thrust Line	
		Level	13 1/2 in.
		Ground Angle	11 deg-03 min
Dimensions and Areas			
Wing Span	32 ft-10 1/2 in.		
Length Overall	24 ft-3 1/2 in.		
Height Overall	6 ft-7 3/4 in.		
Wing Area	161.2 sq ft		
Stabilizer	18.62 sq ft		
Elevator Area	13.75 sq ft		

Center-wing section of the PT-25. It has torque box construction for the nose and contains the plywood gas tank cells.

The Seagull, Navy scout observation plane.



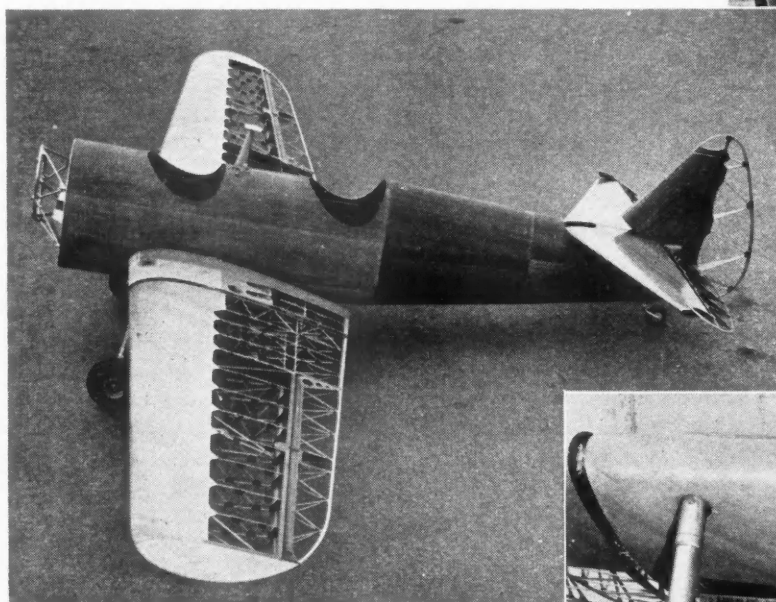
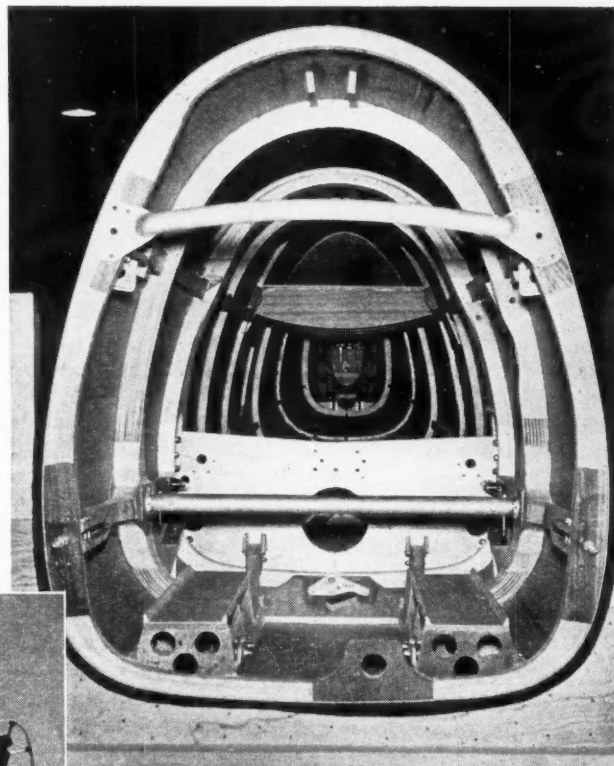
PT-25 fuselage close-up showing laminated spruce bulkheads, built-up center-wing spar, the engine mount tie-through bar (above), and the torque bar (below), which ties together the leading edges of wings and landing gear trusses.

r for Army

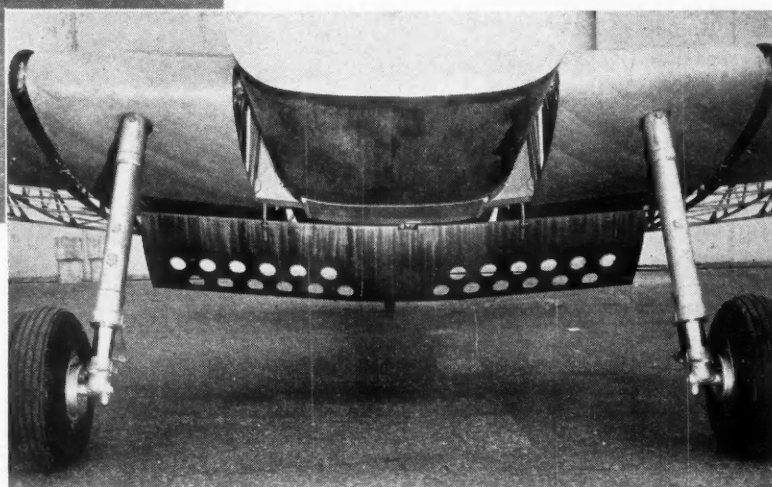
Ryan St-4 (PT-25) Performance Summary

Maximum Speed—Level Flight (Sea Level).....	149 mph
Cruising Speed (75% power).....	134 mph
Rate of Climb—Full Power (Sea Level).....	1,590 fpm
Range—(Operating Speed).....	378 miles
Time of Climb to..... 3,281 ft	2.5 min
Time of Climb to..... 6,562 ft	5.0 min
Time of Climb to..... 9,842 ft	8.5 min
Time of Climb to..... 10,000 ft	8.7 min
Service Ceiling.....	20,300 ft
Absolute Ceiling.....	21,900 ft
Take-off Run—To clear 50 ft. obstacle (Sea Level).....	673 ft
Landing Run—Power Off—Over 50 ft. obstacle to stop (Sea Level).....	978 ft
Endurance at Operating Speed (110 mph).....	3.44 hr

(All performance figures based on a design gross weight of 1800 lb. and with Wickwire-Spencer Automatic Variable Pitch Propeller.)

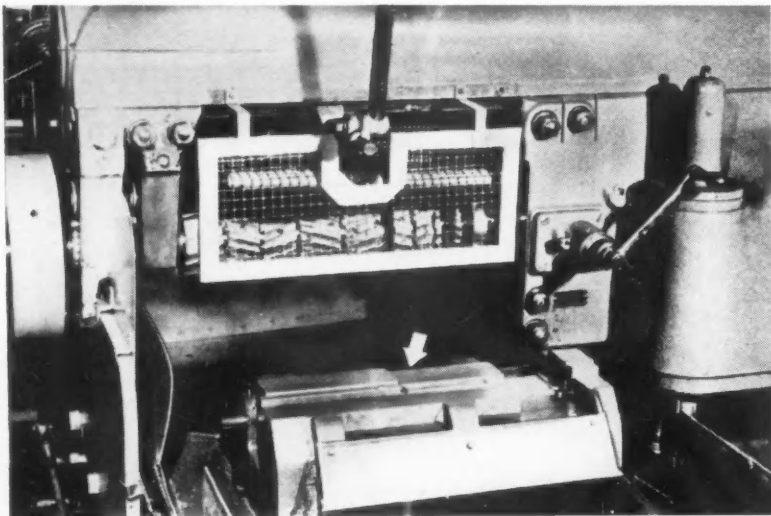


Landing gear, air brakes and the center-section perforated flap of the PT-25.



Structural features of the new Ryan PT-25. The monospar wing construction employs a formed leading edge, completing the torque box, with full cantilever trailing edge. The fuselage is built in two sections—the tail cone and cockpit section. Each is covered with four sheets of plywood; a lower panel, two side panels and a top panel.

Conservation of Critical Materials



Milling nine side plates at a time at AC Spark Plug and Frigidaire Divisions.

STIMULATED by the leadership of Major-General L. H. Campbell, Jr., Chief of Ordnance, manufacturers in the automotive industry have had the cooperation of the staff of Army Ordnance in a gigantic program of conservation of critical materials, man-hours, and machine time per operation.

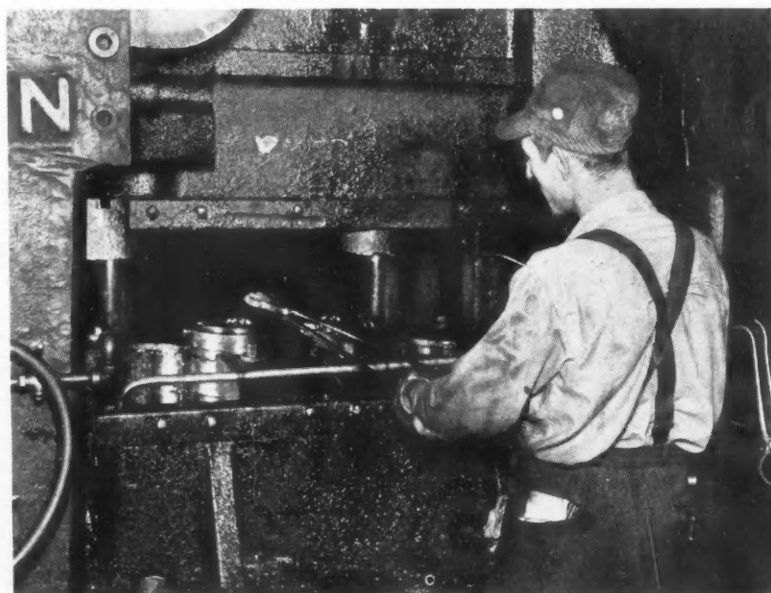
In this alloy steel war there has been enlisted the aid of all branches of the armed services and the Navy, placing the metallurgists of this country in a position of prominence and great responsibility. The over-all program has had the benefit of the contributions of leaders in the automotive industry. Actually, so far as our industry goes, the war emergency is but an intensified and broadened aspect of an every-day conservation and improvement program which is part and parcel of its usual course of progress.

However, it is necessary that the inertia of this movement be impressed upon all manufacturers, large and small, and in all fields if its full benefits are to

be realized. It is to this end that the War Department has authorized the publication of case histories and specific examples of savings in materials, savings in production costs, improvements in manufacturing process, and examples of radical re-design.

Army Ordnance issued two publications late in 1942, designed to put across the conservation principle in simple terms. The first of these—"Tremendous Trifles"—carries the message: "Redesign every tremendous trifle and every complete unit that can be made of less critical materials on less critical machines." The later publication—"Metalurgency"—touches on the role of the metallurgist in an alloy steel war; outlines specific savings that have been effected by substituting N.E. steels as well as low carbon steel for alloy steels, with huge savings in nickel, chromium, molybdenum, and other alloys.

Heat treatment, another aspect of metallurgy, has been responsible for more conservation than any other single device through new ways of developing the needed physical properties. For example, armor plate which has constituted the heaviest drain on hardening and toughening alloys now shows a monthly saving of 520 tons of nickel, 100 tons of chromium, 16 tons of vanadium, by refinement of heat treatment. Similarly, in the space of several months, improved metal-



Huge National Maxipres used by Timken for producing differential pinions complete with finished gear teeth which require no further machining.

Materials-

Man-hours-

Machine Time

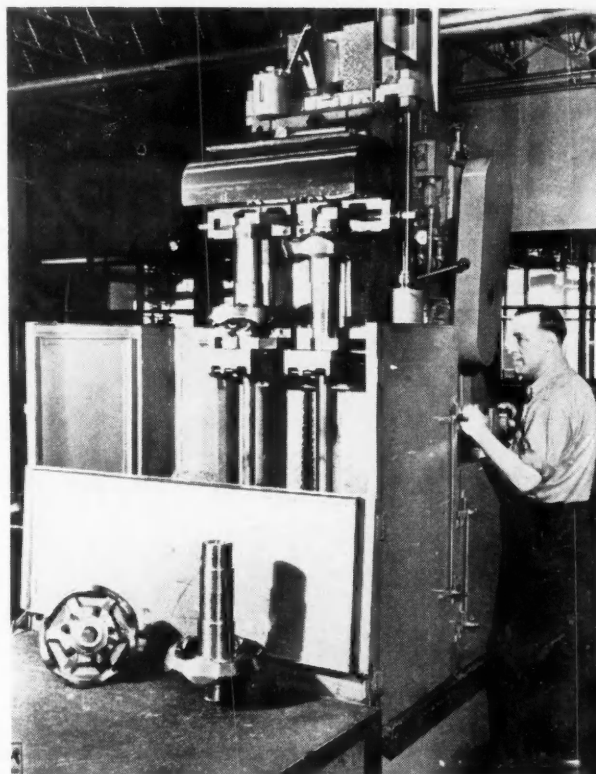
lurgical methods have made possible monthly savings of 90 tons of nickel and 20 tons of chromium on but two sizes of armor-piercing projectiles.

Induction heat treatment, encouraged by the peacetime activity in the automotive industry, is credited with a substantial share of savings in the manufacture of tank parts of many kinds.

"Metalurgency" gives the following comparative figures on the reduction of critical materials due to redesign and conservation on the medium tank:

<i>Material</i>	<i>Reduction in Use in 1942 (per cent)</i>
Aluminum	41
Chromium	44
Copper	55
Vanadium	99.9
Nickel	75
Tin	21
Rubber (crude)	36

General Motors Corp., with its far-flung divisional activities engaged in the war effort has contributed a



Two-spindle inverted deep hole drill employed at Chevrolet for drilling the large center hole in propeller shaft. Similar equipment made by Baker Bros., is used by Bendix for boring large landing gear cylinders.

great number of case studies which may well serve to stimulate the smaller companies of the industry as well as producers in other fields. A few selected examples, suitably illustrated, will provide a good cross-section of this activity.

1. At AC Spark Plug and Frigidaire Divisions, production of side plates for Browning machine guns has been increased by the use of multiple set-ups on Cincinnati and Kearney & Trecker milling machines and by the adoption of punch press operations to replace machining.

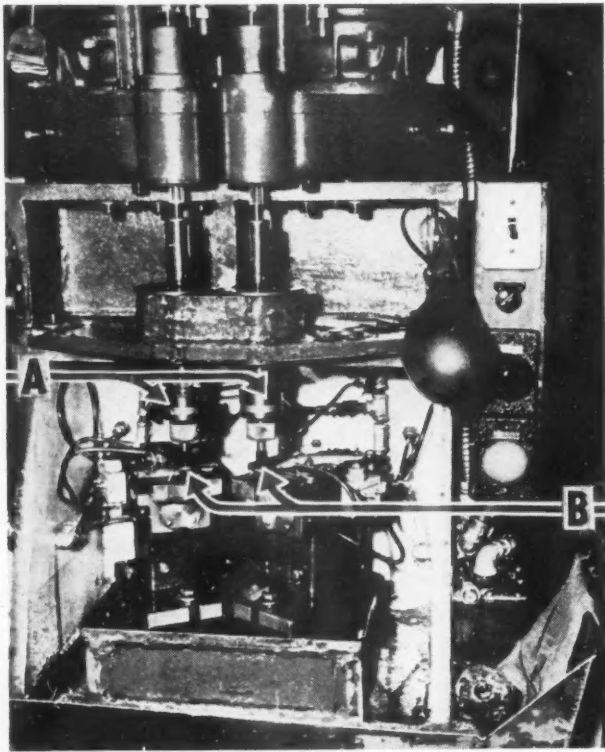
The milling of top and bottom contours of side plates, in which nine pieces are handled at a time is shown at the top of the facing page. Formerly, this required five operations per piece. This saves 16 min of time per gun.

The view at the left shows the use of eight press operations, replacing 10 machining operations on the side plates, for a saving of 62 min per gun.

2. At the beginning of the projectile program at Delco Products, fuse threads were tapped on a single-spindle machine having a maximum capacity of 150 per hour. Today production has been stepped up to 750 per hour by the development



Punch press operations replace machining on side plates at AC and Frigidaire.



Two-spindle tapping machine increased production by 500 per cent at Delco Products in tapping projectile fuse threads. (A—Automatic. B—Twin spindle.)

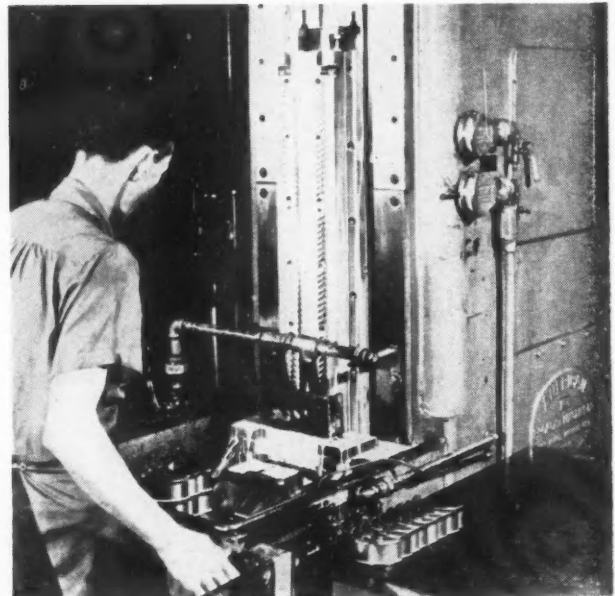
of a special two-spindle, automatic tapper (above).

3. Adoption of automotive surface broaching by Allison has increased production of intermediate crankshaft bearings by 400 per cent, reduced man-hours by 80 per cent. Formerly the joint faces were rough-ground, now they are broached on the American vertical surface broaching machine (shown at the right) releasing grinders for other duties.

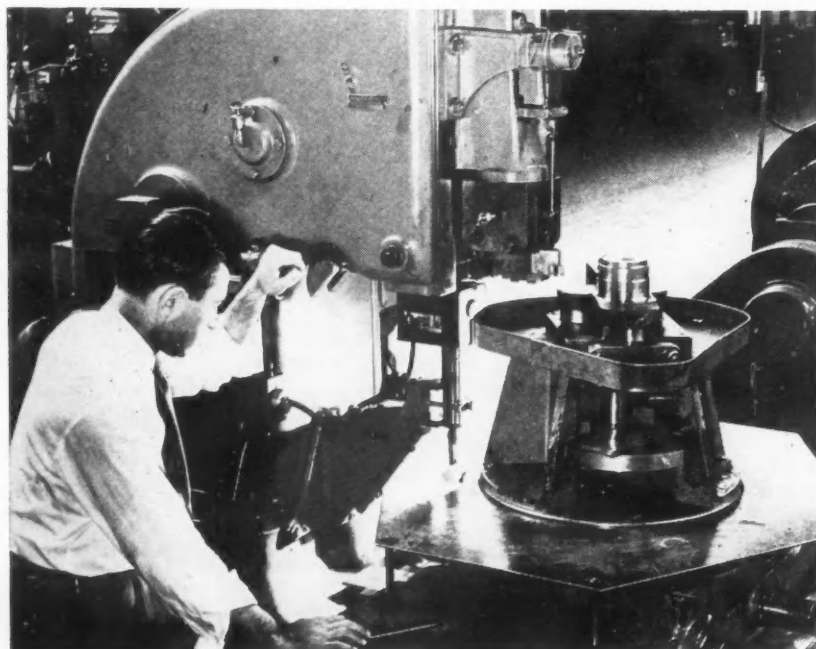
4. Not so long ago when the writer visited the Alli-

son plant, cylinder heads and other large parts were lapped manually on a cast iron plate. Today the joint faces are lapped on a special automatic precision lapping machine, releasing two men for other work, increasing production by 69 per cent, improving quality.

5. Up to now all of the burring on airplane engine elements such as the cylinder head has been done by hand using portable electric tools. At Chevrolet the burring of rocker arm boxes in the cylinder head is done by sand blasting in cabinets such as made by Pangborn, then removing the large burrs by grinding. This is done in 6 min as against 20 min by the former method.



American surface broaching machine used at Allison on intermediate crankshaft bearings, replaced the former method of grinding, increasing production by 400 per cent, reducing man-hours by 80 per cent.

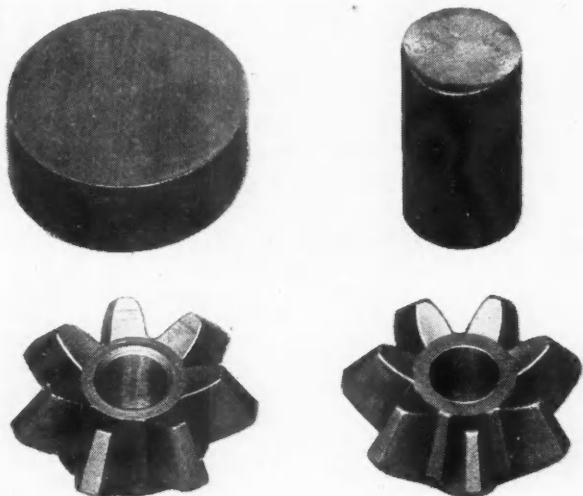
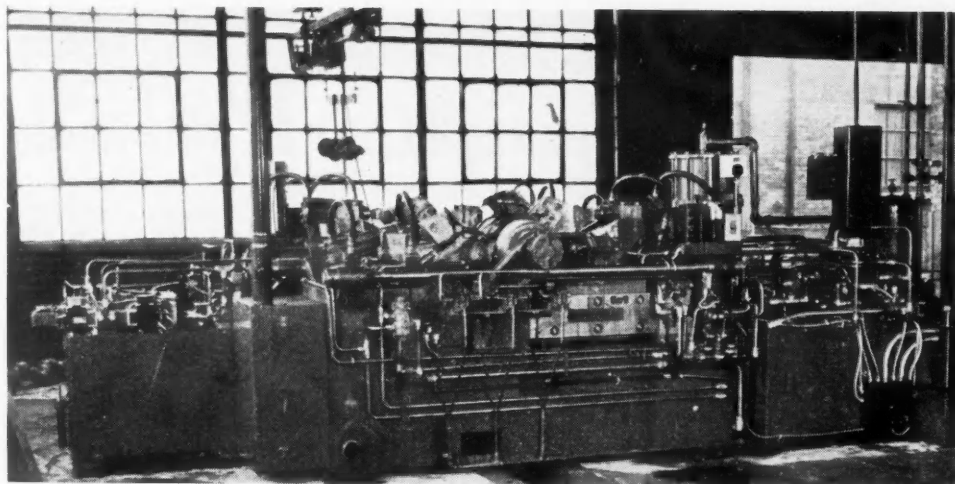


6. Initially, one of the methods of profiling crankshaft counterweights was to machine on a horizontal shaper, using a template for contour control. At Chevrolet, Pratt & Whitney counterweights are finished on a vertical shaper (shown at bottom of this page) fitted with a Kelly tracer control to provide automatic contour shaping. This increases productivity by 75 per cent, improves quality, and produces a saving of 67 per cent in man-hours.

7. Chevrolet has effected a 100 per cent increase in productivity in drill-

Chevrolet now uses this vertical shaper with Kelly tracer control for profiling P & W engine crankshaft counterweights. This was done formerly on a horizontal shaper. New method increases output by 75 per cent, saves 67 per cent man-hours.

Buick now uses this huge National resistance welding machine for welding on four Diesel engine crankshaft balancers in a single setting. The balancers were formerly welded on individually. Production has been increased to 36 shafts per hour, compared with but two to three.



Visual evidence of saving in steel effected by new Timken process. Illustration shows the difference in blank weight for each of the two sizes of pinions.

simultaneously. The increase in production is from the former rate of 2 to 3 shafts per hour, to 36 per hour.

Consider just a few examples of critical materials savings made by GM divisions. Detroit Diesel has eliminated the use of tin-plating on pistons for its two-cycle Diesel engines. The Parker Lubrizing process now replaces tin-plating without affecting interchangeability.

Harrison Radiator Div., has made some marked improvements in design stemming from efforts in conservation. For example, the Prestone aviation radiator formerly required 12 fittings, and was comprised of 9112 extruded copper tubes. The new design consists of 816 flat tubes, sheet fins bake-soldered into header plates, with only four fittings. The new assembly is 56 lb lighter when filled.

On the 0.30 caliber machine gun made by Saginaw Steering Gear, the front barrel bearing bands and plug locks were made of seamless steel tubing. By using stampings instead, Saginaw has released seamless steel tubing for other purposes, has cut the cost from 22 cents per gun to 5 cents.

Consider now a revolutionary method developed by Timken-Detroit Axle Co., in the production of High Traction differential pinions. This process makes it possible for the first time to forge the pinions from the rough, producing gear teeth which require no further gear cutting or finishing operations. It is claimed that pinions produced by this method are so perfect in every detail that only three operations are required after leaving the forging machine—boring the hole, chamfering the bore, finishing the back face.

(Turn to page 64, please)

ing the large center hole in the propeller shaft forging by the introduction of the two-spindle inverted deep hole drilling machine (top of page 27). Similar equipment made by Baker Bros., is used in other plants, as for example, in the boring of the large holes in landing gear cylinders at Bendix.

8. The production of large Diesel engine crankshafts at Buick has been increased tremendously by the introduction of a new National welding machine (top of this page). The problem is the welding of four balancers, formerly welded-on separately. The new National resistance welder permits the attachment of all four

Illustrated here are the five stages in the production of pinions by the new Timken technique. Note the small amount of flash left by the first and second forging operations.



Redesign of a 40-Mm Gun Carriage

IN FEBRUARY, 1941, the Firestone Tire & Rubber Company was approached by the commanding officer of the Cleveland Ordnance District with a request that this company consider the redesign and manufacture of a 40-mm anti-aircraft gun carriage. This gun carriage was to be built on the lines of the Swedish Bofors anti-aircraft cannon.

An imported mount was made available for our study. Such drawings as were furnished showed dimensions in the metric system, and employed metric or first-angle projections. It was necessary to transpose all these drawings to accord with United States Ordnance Standards, which involved the redrawing, and in many instances the redesigning, of approximately 1400

separate drawings and the introduction of 460 U. S. Government standard data sheets for parts such as nuts, bolts, screws, and washers. Another extremely important transposition involved changes of all materials used in fabrication to materials available within the United States. In most cases these material changes were accomplished without reduction of physical properties, by taking full advantage of processing and heat-treating methods proven by modern metallurgy. A total of 1485 individual parts are required for the gun carriage.

During the redesign period, many design changes were proposed, and approved by the Ordnance Department. Important design changes which are saving millions of dollars in machine tools and in man-hours of labor are the employment of welded construction, the use of a single instead of a double ball thrust bearing for the traversing gear, the elimination of thrust bearings in the elevating gears, the use of bearings made from powdered and sintered metals instead of solid bronze, a tubular, welded axle construction instead of a forged axle, a change in the method of mounting the gun trunnions on the top carriage, the employment of rubber bumpers instead of a steel spring within the draft connector, and the use of four-wheel electric instead of two-wheel hydraulic brakes. Of these the most important change was the use of welded instead of riveted construction. The ordnance designers had suggested that we investigate the possibility of

welded construction for the chassis and top carriage. Welded designs for these parts were developed by Firestone, assisted by sub-contractor engineers, and the use of welding was extended to include many other components. This redesign was rendered more difficult by the fact that it had to be carried through simultaneously with the transformation from the metric to the American system and with the change from foreign to American materials, while the time lost in getting into production had to be held to the minimum. The weldability of each material forming part

of a welded assembly was carefully considered, and chemical analyses were controlled to give the best welding characteristics consistent with the designing engineers' strength requirements. To insure relief of local stresses set up by welding and during the cooling from welding temperatures, it was decided to

stress-relieve all important weldments. Therefore, the minimum design strength of each welded material was determined in terms of its room temperature strength after exposure to 1150 F for a minimum of one hour.

In order to meet the strength requirements of the Ordnance Department, the plates used in the redesigned gun carriage were made 50 per cent thicker. As the drawings were completed, they were immediately used for the construction of parts for two experimental models, which were completed soon after the last of the drawings had been made. Gun breeches and tubes were obtained from a Canadian source, and exhaustive roadability and firing tests were conducted at Aberdeen Proving Grounds. These tests proved the general excellence of the redesigned welded carriage, although

By Dr. John L. Miller

Chief Metallurgist, Gun-Mount Division,
The Firestone Tire & Rubber Co., Akron, Ohio

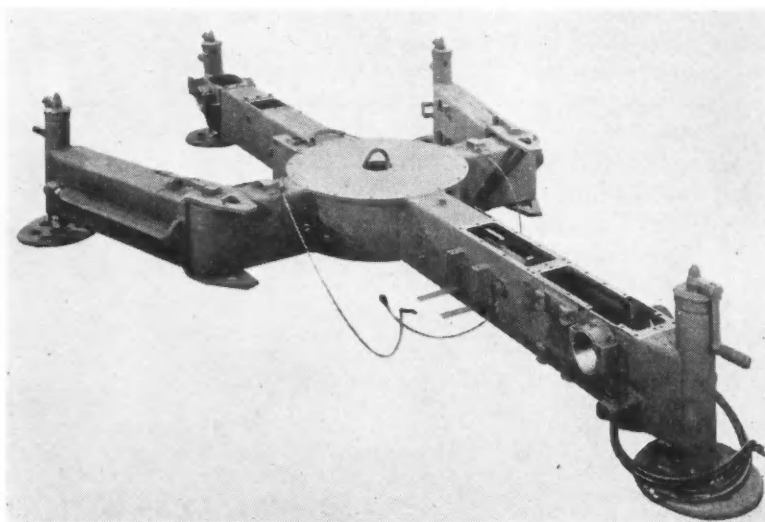


Fig. 1—The welded chassis

Condensed from the Second Grand Award paper in the 1940-42 Industrial Progress Award Program sponsored by the James F. Lincoln Arc-Welding Foundation, Cleveland, Ohio.

Carriage for Welding

slight increases in some sectional thicknesses were made subsequently, a strengthening member was added at the front of the carriage, and the draft connector was made longer and heavier. This redesigned and improved carriage now is able to travel at the highest speed of which the prime mover is capable, and can be placed in firing position in one minute, with complete assurance that the firing accuracy has not been impaired. The actual firing accuracy is dependent as much upon the strength and accuracy of the carriage as on the precision of the breech and tube, because the elevating and traversing mechanisms form part of the carriage, and these must be manufactured to extremely close tolerances. Any lack of rigidity in the gun carriage would result in overstressing, with consequent distortion. This carriage, then, is not only a means of conveyance for the gun, but an integral part which affects the operation of the gun itself.

During the redesign period, detailed estimates of the expected costs of riveted and welded constructions were developed. These estimates indicated that a welded construction would save considerable money and labor, and the employment of welding jigs and fixtures made the welded construction advantageous for quantity production, with a minimum of delay. The design of carriage details is not static, but whatever changes are made, it is necessary that each important part or sub-assembly be interchangeable with foreign models and with carriages produced during other periods. This is such an important consideration that many desirable changes are not made.

Welded vs. Riveted Construction

The entire frame structures of the original Bofors gun and of the English adaptation of it were riveted. This included as major items the chassis, the top carriage, and the elevating gear segment. More than 1000 rivets were required to complete these assemblies.

Because of the need for greater strength, to permit of the higher road speeds contemplated, the American carriage necessarily came out heavier than the English and Bofors constructions. In order to obtain a comparable picture of the weight advantages accruing from the employment of welded instead of riveted construction, data are presented showing the actual weight of the American model sub-assembly, the weight of the corresponding English riveted sub-assembly, and finally what this weight would be if riveted construction were used and the section thicknesses were the same as employed in the American model.

At present, three sub-contractors are engaged in the manufacture of the chassis. Each contractor is required to train welders so that they may be able to qualify in accordance with the requirements of Federal Specifications WXS-31, "Welding of Steel, Arc, General Specifications For," and AXS-476, "Radio-graphic Inspection of Welds."

The Carriage Chassis

As shown in Fig. 1, the chassis is of the box-girder type and has two outriggers. The steel used is of the low-alloy, high-strength type and is supplied under Federal Specification 57-114-1, Class B, Grade 2, which

Table I

Physical Properties and Chemical Composition—Experimental Plain Carbon-Steel Welds on Low-Alloy, High-Strength Steel

Yield Strength, Psi	Tensile Strength, Psi	Elongation % Free Bend Test	Average Chemical Analysis	
60,960	84,020	38.0	Carbon	0.15 percent
59,580	79,540	56.0		
55,580	78,900	42.0	Manganese	0.53 percent
58,160	77,790	46.0		
59,910	76,930	44.2	Silicon	0.43 percent
54,440	80,100	54.0		
57,000	79,030	45.2	Chromium	0.31 percent
57,440	78,860	48.0		
53,570	77,620	62.0	Nitrogen	0.015 percent
59,050	77,850	39.5		

places a maximum limit of 0.25 per cent on the carbon, leaving other elements unrestricted. It also calls for a minimum yield strength of 50,000 psi, a tensile strength of 95,000 psi, and a minimum elongation of 20 per cent in 2 in. The material actually used conforms to the following specification:

Carbon	.10-.20 percent	Zirconium	.10-.20 percent
Manganese	.50-.70 percent	Sulphur	.04 percent max.
Silicon	.60-.90 percent	Phosphorus	.04 percent max.
Chromium	.50-.65 percent		

The plates forming the box sections are 3/16 in. thick; those forming the tub or central section, 1/2 in. and 3/16 in. All of the sub-assemblies are positioned for welding, the fixtures required usually being built in the plants of the sub-contractors. Plain carbon steel, covered electrodes of 5/32 in. diameter are used. No special preparation of the joints is necessary, and a low-carbon-steel backing-up strip is employed. Sixty-six pounds of 5/32-in. electrode is required for the complete welding of the chassis. In Table I are shown typical physical properties secured on experimental

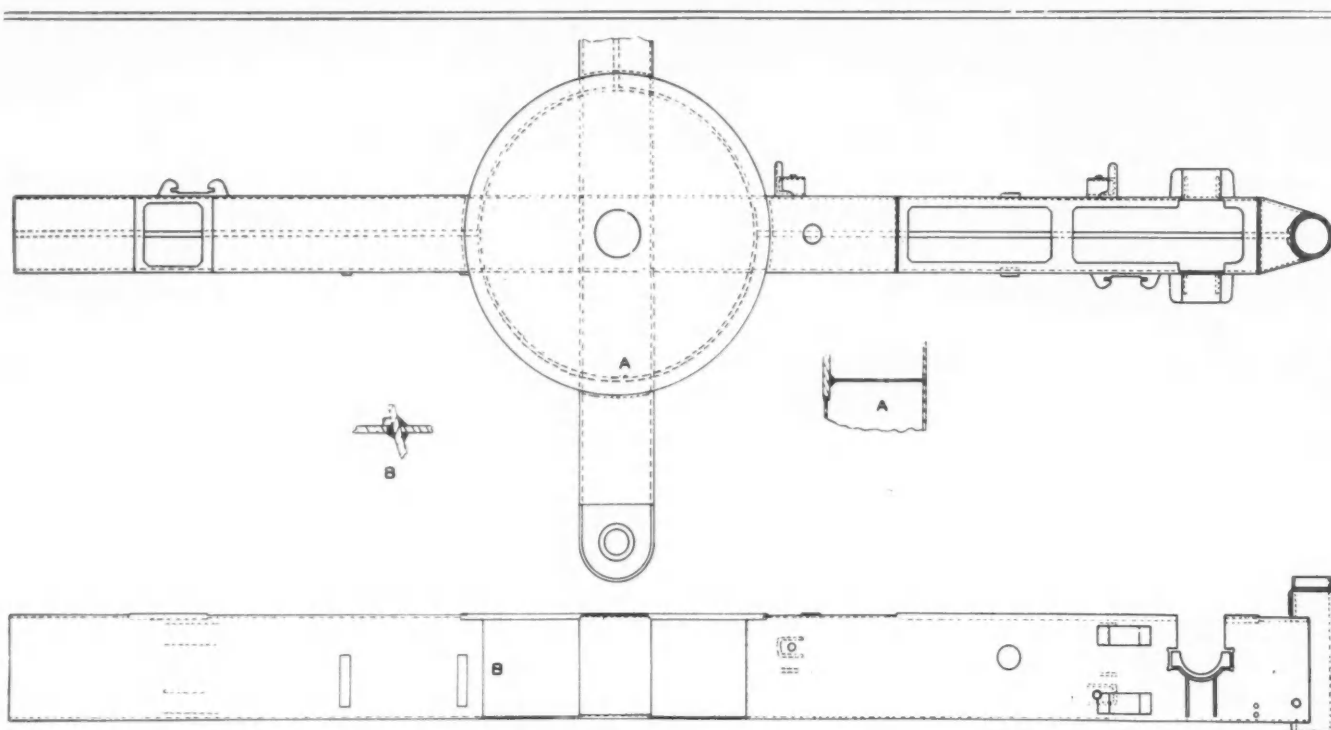


Fig. 2—Showing welded joints on main body of chassis

test plates, which had been stress-relieved at 1150 F. Included in this table is a typical weld-metal chemical analysis as obtained from single-bead welds made on 3/16-in. butt welds.

Fig. 1 shows the welded construction now being used and in Figs. 2 and 3 are presented line drawings indicating the locations and general features of the welds. A number of photographic views of details which clearly portray differences in the welded and riveted designs are reproduced herewith. Figs. 4 and 5 contrast the designs employed in forming the bottom section of the drum or central section. The foreign design does not completely cover the bottom of the tub. Obviously this would be impossible, because of the necessity for getting inside for riveting. It will be noted that a double plate is required to secure the needed strength. The welded design provides for a single plate which completely covers the tub bottom, thus adding needed strength without the necessity of having an additional plate. At the front or swivel end of the foreign model, Fig. 6, a needlessly-expensive method of securing the bearing surface for the axle tube was used. The redesigned model, Fig. 7, employs powdered and sintered metal bearings for the axle tube. The simplified lines and the increased rigidity made possible by the use of arc welding are apparent.

Rigidity Tests

Exhaustive deflection tests to determine the rigidity of the chassis as compared with that of the imported model were made to check the redesign calculations and the unit strength of the metals and welds in the new chassis. One such test will be described:

Two chassis, one the English riveted model, the

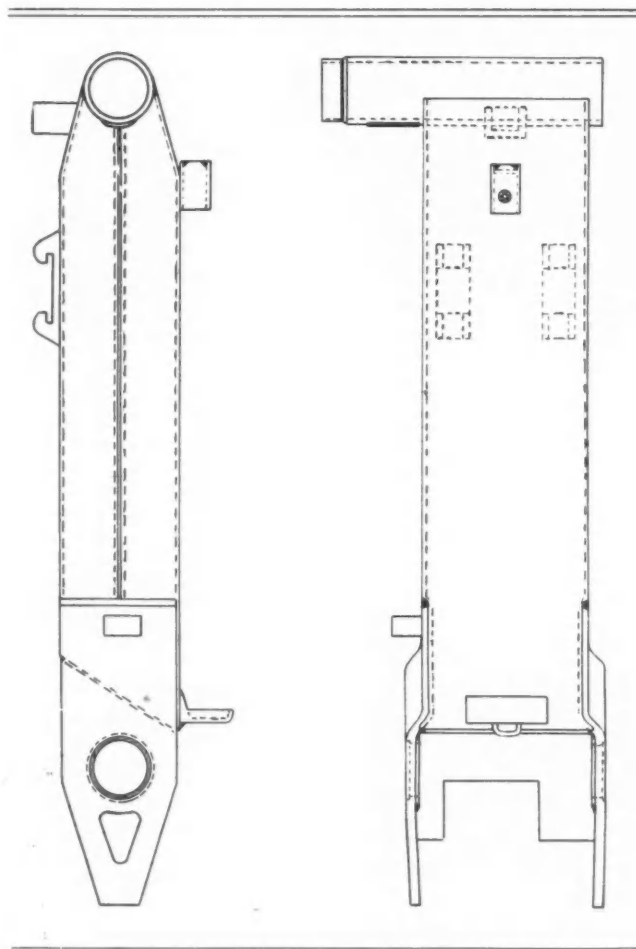


Fig. 3—Showing welded joints on outriggers secured to main body

other our welded chassis, were placed on a level concrete floor in a position as indicated in Fig. 8. Six dial indicators graduated in thousandths of an inch then were mounted on separate supports under the central or tub section, at equal angular spacings. A 3000-lb weight—representing a static overload of 75 per cent—was placed on top of the central or tub section, and the deflection on each of the six dial indicators was noted. This test was repeated several times, with the following average results:

Riveted chassis—0.079 in. deflection

Welded chassis—0.051 in. deflection

The difference of 0.028 in. in favor of the welded chassis corresponds to $(.028/.05) \times 100 = 55$ per cent greater rigidity. Both chassis returned to their

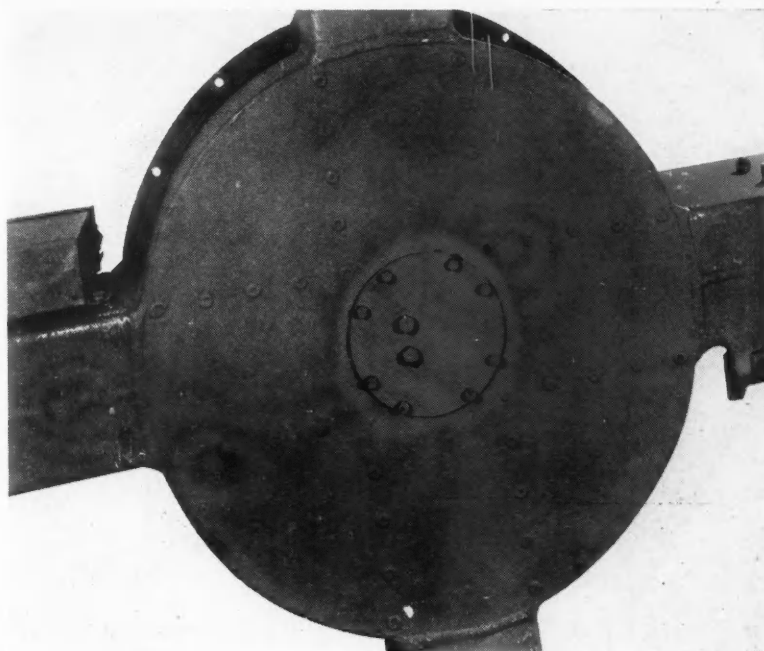


Fig. 5—Bottom view of welded tub or central section

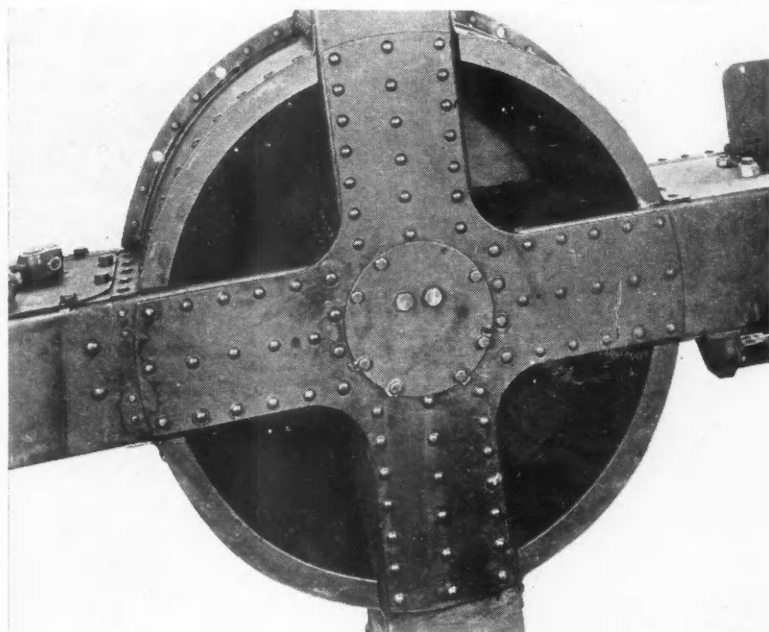


Fig. 4—Bottom view of riveted tub or central section

original positions when the loads were removed, indicating that the stress in each case was completely within the elastic limit and that the load was not sufficient to produce plastic or permanent deformation.

The weight of the riveted chassis is 824 lb, that of our welded chassis without the steering support, 1071 lb. The weight difference of 247 lb, combined with the welded design, has produced this 55 per cent increase in rigidity. The welded chassis functions as an integral unit under stress, and the nose piece, Fig. 7, which is not present in the foreign design, adds greatly to the strength of the front end of the carriage as it

forms a rigid support for the steering mechanism.

Materials Used

In order to insure weldability of all brackets, supports and locks which are attached to the chassis, the chemical analysis of each part was closely controlled, and the specifications for physical properties were established with these chemical limitations in mind.

All of the welds shown in the illustrations and drawings are single-bead, plain-

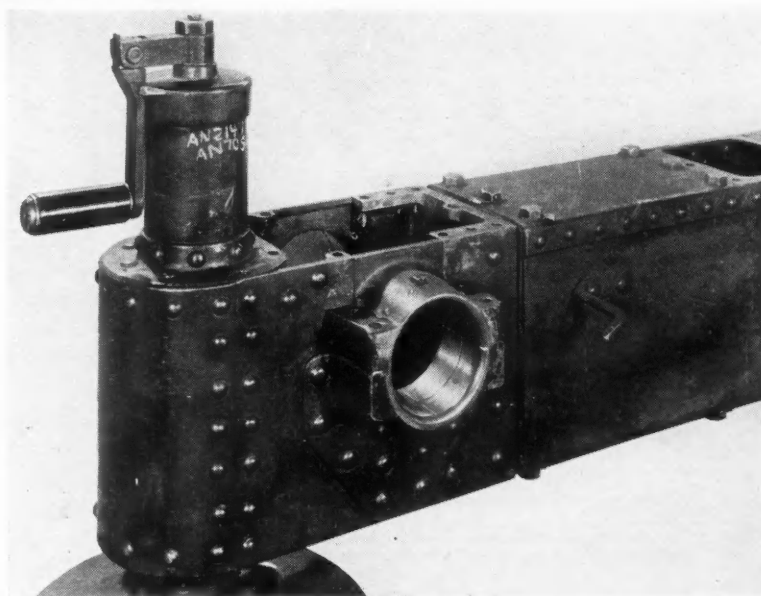


Fig. 6—The front or swivel end of the riveted model

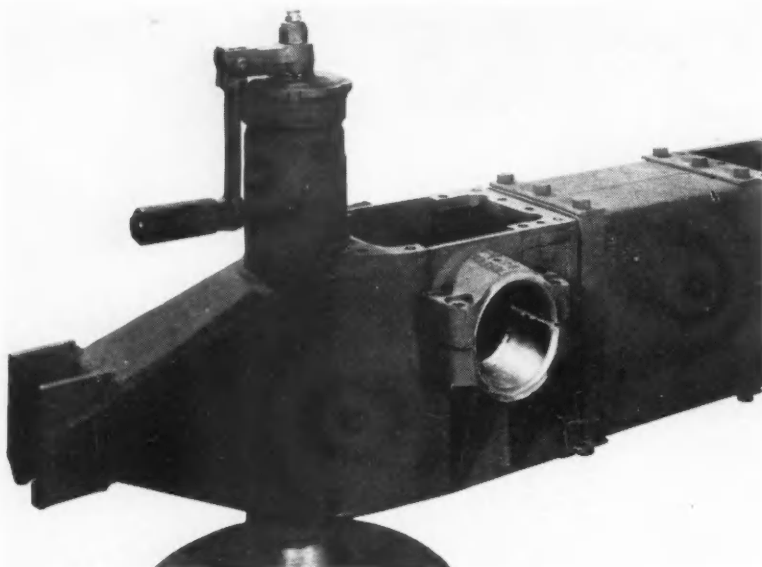


Fig. 7—The front or swivel end of the welded model

carbon-steel, covered-electrode, metallic-arc deposits. For the frame proper, a low-carbon steel backing-up strip is employed, with little scarfing or other preparation of the welded joint required. Pickup of alloying elements from the alloy plate during welding assures weld metal physical properties comparable with the values characteristic of the plate material. Check tests give results similar to those shown in Table I.

Cost Data

Comparable total labor costs for the riveted and welded constructions were developed for the chassis. The estimates indicated that 282 man-hours of labor would be required for the riveted, and only 218 man-hours for the welded construction. A charge of \$.004 per pound of metal for stress relieving was added to the welded-construction total labor charge. In these preliminary estimates, the assumption was made that

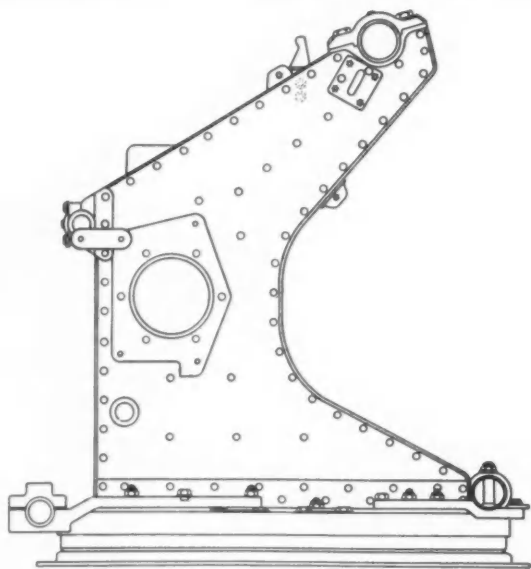


Fig. 9—The riveted top carriage

the material costs would be about the same, and no effort to develop relative costs in terms of material differences was made. Based on an hourly rate of \$1.20, this preliminary estimate indicated that a saving of \$76.80 per chassis could be effected if welded construction were adopted. The actual total costs of the welded construction reported during May, 1942, was \$409.42, which does not include overhead.

Top Carriage

After the advantages of the welded construction applied to the chassis had been demonstrated, a study applied to the top carriage indicated that a welded design would be both cheaper and stronger. The redesigned top carriage weighs 300 lb, as compared with 264 lb for the foreign, riveted construction, and a calculated weight of 317 lb for a riveted design of equivalent thickness. This top carriage is made by attaching the uprights to the turntable of pressed and formed parts welded together. These parts are formed from the same quality steel as

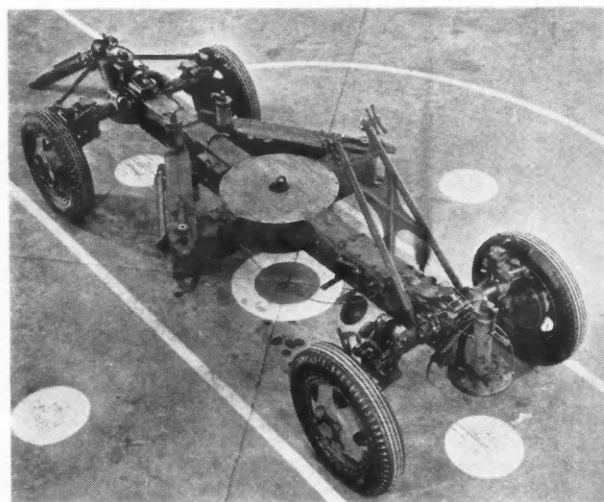


Fig. 8—Gun carriage ready for mounting the top carriage and mechanism

used in the plate construction of the chassis. The high-strength, low-alloy steel plates forming the upright box section are punched, placed in welding jigs, and edge- and slot-welded together. In Figs. 9 and 10 the general design features of the foreign, riveted and the welded top carriage are shown. The different angle of mounting and the different bearing construction employed for the breech connection are apparent, as are the slot-type welds used in joining the side plates to the internal stiffeners.

A preliminary estimate gave the cost of the riveted top carriage as \$130.65, while the actual cost for the welded one was \$120.28.

The elevating arc is mounted at the bottom of the

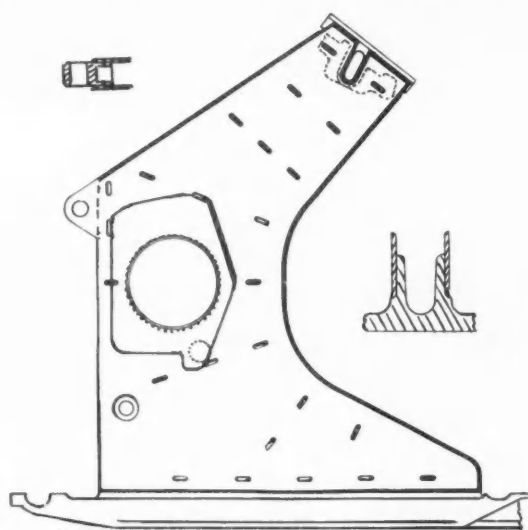


Fig. 10—The welded top carriage

breech and engages a gear mechanism attached to the top carriage, which permits the gun to elevate through an arc of minus 5 ft to plus 90 deg.

In order to eliminate cracking and to minimize distortion, all welds are staggered during deposition. This precaution has been necessary particularly in view of the use of heat-treated WD X4130 steel for the gear itself. The gear sector is stress relieved at 1150 F after welding, and then machined. The same steel thickness was used in both the riveted and the welded sectors, and this part offers a direct comparison as to the weight advantage of welding where additional strength is not required. The riveted construction weighs 42 lb, or 3½ lb more than the welded one. Preliminary estimates had shown a cost of \$2.96 for the assembly of the riveted construction. The actual welding cost for the gear sector—as of May 1, 1942—was \$1.61 per unit.

Front and Rear Axles

The axles of the foreign models had been forged by upsetting the ends of solid steel bars and then machining—a method of production that is relatively expensive, needlessly wasteful of material, and slow. The axles used on the redesigned carriage were fabricated from WD 1035 tubing, cold drawn and finish annealed, to which were welded cast-steel heads. The weld joints are prepared by machining before welding. The axles are positioned for welding, and welding is done with ¼-in. covered electrode, carbon-molybdenum steel rods. The estimated cost for material and labor of an axle made in the foreign manner was \$110.00, which compares with a cost of \$42.08 for the tube-and-welded construction. This item is sub-contracted, and no actual cost data are available, but the placing of an additional contract at a

price lower than the original indicates that this estimated cost is not being exceeded.

Other Parts

Many other small parts used on the gun carriage were redesigned for welded construction. On the stakes used to fasten the gun carriage securely in the firing position, a saving of \$1.08 per unit is effected by welding. The foot plates are another example of the completeness of the redesign for welded construction. They are secured to the four jack screws which are used to support and level the gun carriage while in the firing position. A cost advantage of \$.15 per plate in favor of the welded construction has been realized.

Another small part redesigned to take full advantage of welding is the gun stay or support which holds the gun tube in a rigid position during travel. Welding is employed also in the fabrication of the equilibrators, the draw bar, and the carriage platform.

Summary of Sub-Assembly Weights and Cost Savings

Table II is a summary of the weights of the more important redesigned welded sub-assemblies, the comparable weights for the English model, and the calculated weights of a riveted design having the same metal thicknesses as used in the welded carriage.

In view of the nature of many of the sub-contracts, it is not possible to show in a definite way the money savings that have resulted from the employment of welded construction. From the information now at hand, the indicated saving is approximately \$160.00

Table II

Part Name	Weight Comparisons		
	American Welded Model	English Riveted Model	Calculated Riveted Model
Chassis.....	1084	824	1155
Top Carriage.....	300	264	317
Gear Sector.....	38.5	42	42
Front Axle.....	114	97*	121
Rear Axle.....	114	84*	108
Stake (4).....	21.5	18	22
Foot Plate (4).....	9.5	7.5	10.0
Gun Stay.....	60.5	58.5	62.0

* These parts are forged, not riveted.

per gun carriage. Considered by itself, this saving appears large, but owing to the cost of materials, and the cost of the precision machine work required on so many of the parts (which items are in no way influenced by the welded design), the actual saving is a rather small fraction of the total cost of the gun carriage.

In times like these, cost in itself cannot be the deciding factor in ordnance design. Speed of production and efficiency and reliability in field operation are of greater importance. Several design changes were incorporated in the 40-mm gun carriage to facilitate production and to improve operation, the most important of which was the conversion from a riveted to a welded construction.

WHILE the war is bringing about an accelerated development of air transportation of express, mail and freight, there are literally hosts of varied problems which must be properly intergrated before the whole idea assumes the rosy picture painted by many. That, generally speaking, sums up the over-all thinking of the several hundred members of the Society of Automotive Engineers and others of the aviation industry who staged a two-day session Dec. 8 and 9 at Chicago. This meeting, called the Air Cargo Engineering Meeting, was held under the auspices of the Chicago Section of SAE with the cooperation of the SAE Aircraft Activity, Air Transport Association, and the Aeronautical Chamber of Commerce.

The gathering heard of the great progress made in air cargo through the war effort from authoritative speakers representing the armed forces and the leading automotive and aircraft industries, but likewise they heard about the major deficiencies in the program as well as the technical difficulties of converting passenger planes into cargo ships. The morning and afternoon technical sessions were given over to informative papers on air cargo engineering, operations, design and cargo gliders. Naturally some of the papers overlapped considerably and the trend of thought during the sessions swung more or less rhythmically from craft design to cargo handling.

For example, there were those who voiced the opinion that air cargo would come into its own with great strides when new ships are built, whose designs are a somewhat far cry from the orthodox transport plane made over for cargo carrying purpose. On the other hand, those interested chiefly in operations held out for the designers to build planes and equip them after a pattern which revolved around the freight terminal, cargo handling, systems and equipment. Much valuable material was presented in the papers and discussions, so that when the final curtain came down on the last session, the probable prevailing thought in most minds was that no single airplane or method of cargo handling will solve the problem.

By B. M. Ikert

Air Cargo

Stimulated by Ur

The representatives of the armed forces gave a still different twist to the meeting because quite naturally with them the points stressed considered first of all the urgencies of war, with operations a secondary factor. Safety of operation comes first in normal airline operation, but the Army Air Forces must take chances with cargo which no commercial airline would ever consider. The armed forces were quick to point out that an entire war campaign may depend on getting materials in time.

Another thing brought out and which seemed to be the general feeling was that the airplane potential in the over-all transportation picture still is of a supplemental nature and not one to replace railroads or steamships. The airplane's ability to carry its part of the immense total of tonnage is too sound to be jeopardized by extravagant claims. While each of the technical papers presented dealt with a particular subject, quite a number of common deductions sooner or later came to light, making it possible for those in atten-

Four 1350-hp Pratt & Whitney Twin Wasps power this Douglas C-54 Army transport. It has a 265-mph top speed, a 2200-mile range and a wing span of 117½ ft.

Courtesy of Douglas Aircraft



The Curtiss Commando C-46 military transport is said to have a capacity of 36 fully equipped infantrymen and weighs 50,000 lb. loaded. It is powered by two 1700-hp Wright radials, has a top speed of 254 mph, a range of 2000 miles and a service ceiling of almost 27,000 ft. Its span is 108 ft.



Courtesy of Curtiss-Wright

Urgencies of War

Design and handling problems discussed at SAE Chicago meeting

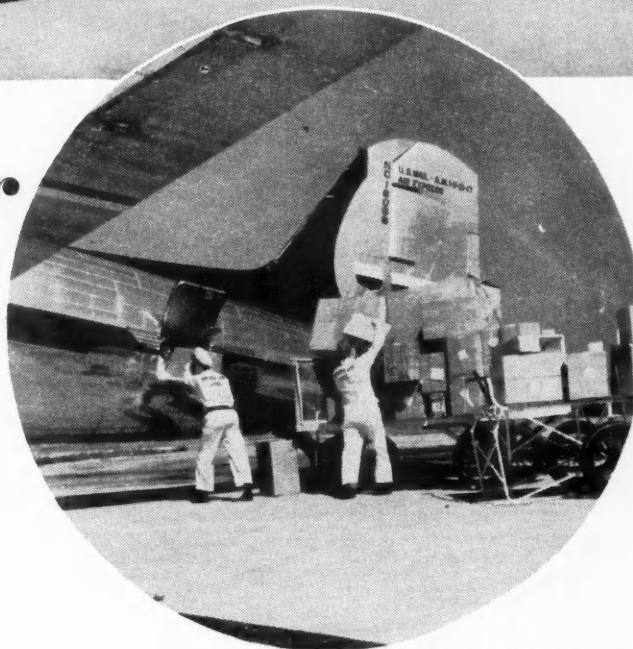
dance to draw rather definite conclusions about air cargo.

The Tuesday morning technical session, true also of the afternoon session and for the following day, opened with a capacity attendance, at which Wm. C. Littlewood, vice president in charge of engineering, American Air Lines, acted as technical chairman. Two excellent papers were presented.

The first, "The Deficiencies of Converted Passenger Airplanes For Cargo Operation Requirements" was given by Charles Froesch, chief engineer, Eastern Air Lines. This paper dealt largely with design structures of present craft and stressed some of the difficulties of loading large packages into the relatively small doors of planes. The many problems of cargo space arrangements, tie-down procedure to eliminate shifting, ramp loading and unloading with present types of converted ships were discussed by the author.

Karl Larson, chief engineer, Northwest Airlines, in presenting a paper "Terminal Handling of Air Cargo" went into considerable detail on present day problems which confront not only the air lines, but the shipper and receiver as well. While better methods of handling shipments are constantly being developed, as yet deliveries cannot be guaranteed on the same basis as is done with rail transportation. At the present time each cargo requires certain handling and with no standards as yet available for the preparation of cargo by the shipper the problem is quite complex.

The author pointed out the difficulties encountered of loading and unloading airplanes because of the extreme variations in the doors of planes as well as the height above ground. This produced quite a bit of discussion as to what might be done in the future



Courtesy of United Air Lines

by equipment manufacturers in the way of flexible, portable loading and unloading devices to facilitate handling goods which may vary from small packages weighing but a few pounds to some cumbersome article which may weigh a thousand pounds or more. As it is now a piece of machinery weighing perhaps 8 or 900 pounds may be loaded into a plane along with other articles, but there is not always assurance that at the other end of the line there will be equal facilities for unloading. Since one of the outstanding features of air cargo is speed considerable time may be lost due to loading or unloading which to a large extent may nullify the advantages of air delivery.

Mr. Larson made clear in his paper that the time consumed in air delivery must be figured from loading at the point of shipment to unloading at the point of destination. Thus, evidently the actual flying time of the cargo is the least source of worry. This may be a matter of only two or three hours but it may be matters of many hours at both ends of the line. It is clear that the work to be done in order to take full advantage of shipments by air is a matter of terminal layouts and terminal operations.

The author went on to show the desirability and in fact necessity of large central terminals fully equipped with machine handling of cargo instead of

(Turn to page 68, please)



Ground unit of the Vultee Radio Flight Test Recorder receives the flow of data from a plane in flight and records it on paper tape, wax disc and sound film. H. D. Giffen, responsible for development of this new equipment, is shown holding the microphone in readiness to communicate with the pilot to alter the schedule of test maneuvers or warn of excessive loads building up within the plane's structure.

EQUIPMENT by which performance data, strains and stresses occurring in aircraft in flight are recorded on the ground has been developed by Vultee Aircraft, Inc., and is known as the Vultee radio flight-test recorder. The readings of 70 different instruments are transmitted from the flight unit of the recorder through the standard radio transmitter on the plane to the receiving station on the ground. Besides the standard test instruments, a number of special gages are included which indicate loads on and positions of the controls, as well as strains in and vibrations of various parts of the ship. Signals are picked up continuously by the ground unit and recorded by three separate media. One of these records the performance of the plane on a ticker-tape, so that it can be continuously observed by the test engineers. Should trouble of any kind develop, a warning can be immediately flashed to the pilot, who may not have observed the symptoms. The signals also are recorded simultaneously on sound film and wax discs. A special apparatus automatically analyzes each signal and plots the data in visual form, so the engineers may study the relations between cause and effect under different conditions of flight.

In the past, observations and instrument readings were made by the test pilots, but the engineers always found it difficult to translate these observations into design improvements. The new equipment eliminates the personal element from test flights. It obsoletes the

Flight Performance

Recorded Automatically

in Ground Station

bulky movie camera equipment for making movies of limited instrument panels that were later studied in "stop motion." A further advantage of the new system of recording test data is that the records will remain intact regardless of any mishap that may befall the test plane.



Sound film records of the entire flight, run through this automatic analyzer, are separated and reproduced as individual graphs of each instrument and gauge. Relations between their various trends can then be studied as a comprehensive and accurate basis for design improvements.

Diesel Engines - Aircraft - Materials

By P. M. Heldt

AT THE annual meeting of the American Society of Mechanical Engineers, held in New York City early in December, a great variety of topics were dealt with, a goodly proportion of which had some bearing on war problems. Aviation subjects were well to the fore, and three separate aviation sessions were held. The Oil and Gas Power Division held one session devoted to Diesel engines and another in conjunction with the Railroad Division, at which progress in Diesel locomotives and gas-turbine locomotives was discussed. Then there was a session under the auspices of the Research Committee on Mechanical Springs at which three papers on volute springs were presented, a subject of timely interest because of the use of such springs in "tanks." There were sessions also devoted to plastics and rubber, and others to problems of machine design, dynamics and production. In the following will be given brief abstracts of some papers which we believe to be of special interest to readers of *AUTOMOTIVE AND AVIATION INDUSTRIES*.

Anti-Friction Bearings

THE SUBJECT of Anti-Friction Bearing Development for Aviation Engines was discussed in a paper by Thomas Barish, who previous to his present connection as manager of the Propeller Division of The Engineering & Research Corporation, Hyattsville, Md., devoted about 20 years to anti-friction bearing development, the last 15 with the Marlin-Rockwell Corporation. Mr. Barish said the problem of providing satisfactory anti-friction bearings for aircraft engines is very difficult, because of the enormous bearing loads in modern high-horse-power engines, the limitations on bearing sizes, the comparatively high speeds of engine crankshafts, and the high temperatures to which the bearings are subjected in service. In a 1000-hp radial engine, for instance, the maximum bearing load is about 14,000 lb at 2000 rpm. The large deflections in aircraft engines are a bothersome factor, moreover. Anti-friction bearings on the crankshaft are used only in radial engines, not in in-line engines, where they are more difficult to fit.

The first type of ball bearing to be used on aircraft engine crankshafts was the full type with lateral filling slot. This was later replaced by the Conrad eccentrically-filled bearing, which for the same overall dimensions contains only about one-half the number of balls, but gets rid of the filling slot which shortens the life of the bearing.

A further step in the improvement of aviation type ball bearings consisted in a reduction of the width of the races from the standard adapted for general purposes. While these successive steps were being taken, the output from an engine of given dimensions was greatly increased—more than doubled, in fact—and

bearings had to be provided that would take care of the increased loads, but they could be no bigger. This finally led to the adoption of cylindrical roller bearings of the general proportions corresponding to ball bearings. Even the roller bearings gave trouble at first. Failure usually started at one end of the roller, because shaft deflection resulted in a concentration of load there. This problem has been solved by providing relief at the end of the roller where this load concentration occurs, to the extent of 0.0002 in. Another improvement in the roller bearing consisted in providing a cage for the rollers which permits of removing the whole set endwise from the outer race for inspection, a feature that was much appreciated by the service men. For satisfactory operation of the bearings it is essential to control the oil flow through them.

Another problem is presented by the bearing at the propeller, which must take the propeller thrust. For this service a special full-type of ball bearing with a split outer race has been developed. The rocker-arm bearings also present a difficult problem. These are so small that they can be readily held in one hand, yet they must carry a maximum bearing load of about two tons. Much of the trouble with aircraft-engine bearings is due to the high temperatures at which they operate. In the rocker-arm bearings the inner race reaches the highest temperature, because heat flows toward it from the cylinder head. It has been found that these inner races reach temperatures of between 400 F and 450 F. There is a definite trend toward the use of plain rocker-arm bearings at present. In this connection the author mentioned that anti-friction bearings are used much more liberally in foreign than in American aircraft engines. For instance, the most popular make of British in-line engine contains a total of 49 ball and roller bearings, while its American counterpart has only three.

The blade-retaining bearing of the variable-pitch propeller is a really difficult problem, since in this location a bearing weighing between 4 and 5 lb must sustain momentary loads of the order of a quarter million pounds. Two types of blade-retaining bearings have been developed, one making use of straight rollers arranged radially, the other consisting of a number of ball bearings mounted side by side. Some difficulty arises from the fact that the races of these bearings must be held comparatively light. In fact, they are so light that they distort appreciably under their own weight when placed on a horizontal surface. In the first of these multi-race ball thrust bearings the races were made substantially symmetrical to a central plane perpendicular to the axis, but it was found that they then had a tendency to "turn inside out" under

the influence of heavy thrust loads. This was remedied by distributing the metal in the outer race more nearly equally to both sides of the load line.

Mr. Barish also referred to ball bearings for centrifugal superchargers or blowers, which present a problem because of the high speeds at which they must operate—more than 30,000 rpm. Here the temperature effect is the opposite of that in other cases, because the main bearing is very close to the impeller, which passes a lot of very cold air, so the bearing housing operates at low temperatures. Outer races usually are made a free fit in their mountings, to allow for the tightness that otherwise would result from the difference in temperature between housing and shaft.

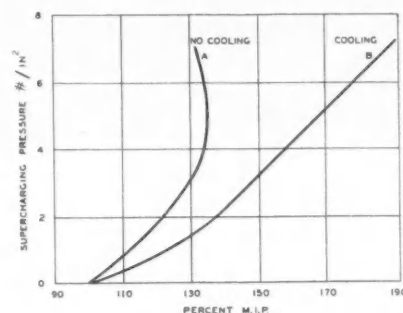
Some trouble has been experienced from galling of supporting surfaces for the blade-retention bearings and also for crankshaft bearings. To prevent galling, the surfaces sometimes are copper-plated. The surest way to prevent galling undoubtedly would be to make the bearing race a press fit, but that is impractical where it has a very light section, as it is then impossible to remove it. In some cases the propellers, which are made of light alloy, must be heat treated after the bearings are in place on them. As this calls for a temperature of around 1000 F, it tends to draw the temper of the race. In the discussion the suggestion was made that the races in that case might be work-hardened by subjecting the bearings to gradually increasing loads, but Mr. Barish said work-hardening was impractical with material as hard as that of ball races.

Rating of Supercharged Diesels

RATING supercharged four-stroke Diesel engines on the basis of the mean temperature of the cycle is a practice that was recommended in a paper by Ralph Miller of the Worthington Pump & Machinery Company of Buffalo. Reference was had largely to large engines in stationary and marine applications. Mr. Miller said with these large engines the maximum power that can be developed continuously is not limited by smoke in the exhaust (incomplete combustion) but by heat stresses. These heat stresses vary with the mean temperature of the cycle. If a supercharged engine of large cylinder dimensions is overloaded, trouble is likely to be experienced with piston rings and other heat-sensitive parts long before a limit is set to the output by smoke in the exhaust. At present, superchargers are being applied to many engines which originally were designed for use as natural-induction engines, and their ratings as non-supercharged engines are based on long experience. The problem confronting the Diesel engineer then is to determine the degree of supercharge, or the increase in output, to which he can go without incurring any greater risk of failure due to excessive heat stresses than in the nonsupercharged engine at its rated load. In his paper the author developed methods of determining the mean cycle temperature of both the nonsupercharged and supercharged engine.

It might be thought that with increase in the air charge due to supercharging and the corresponding increase in the amount of fuel burned, the mean cycle temperature always would be higher in the supercharged engine. That this is not so is due largely to

Variation of i. m. e. p. with charging pressure, with and without "aftercooling."



the fact that in the supercharged engine the inlet and exhaust periods are made to overlap greatly, with the result that all of the hot gases are swept from the combustion chamber and the walls of the chamber are cooled in addition. This, of course, tends to lower the temperature of the air charge at the beginning of the compression stroke, and it was found that this initial air temperature has a very pronounced effect on the mean cycle temperature. In the supercharged engine the initial air temperature can be reduced by after-cooling the blower air.

Mr. Miller found that when supercharged engines are rated at the pressures and mean temperatures obtaining in the nonsupercharged engine, the increase in the mean indicated pressure without aftercooling is 34.5 per cent at the optimum supercharge pressure of 5 psi. This corresponds to an increase of 42 per cent in the brake mean effective pressure. If, on the other hand, the air delivered by the blower is subjected to aftercooling and is cooled to atmospheric temperature, the indicated m.e.p. is increased 87 per cent with a charging pressure of 7 psi, or 70 per cent with a charging pressure of 4 psi. Without aftercooling a charging pressure of 4 psi permits of an increase in the b.m.e.p. of 40 per cent. In land transportation cooling of the charging air to atmospheric temperature would be impractical, but cooling to 20 F above atmosphere would raise the gain in output from 40 per cent without air cooling to 58 per cent with.

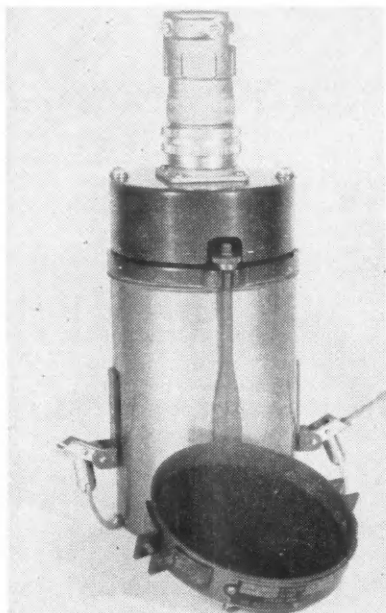
The accompanying chart shows the increase in the mean indicated pressure of the engine with the supercharge pressure both without aftercooling and with cooling to atmospheric pressure.

Definition of "Volumetric Efficiency"

DR. P. H. SCHWEITZER of The Pennsylvania State College proposed a new definition of the term "volumetric efficiency" which would make it applicable to two-stroke and supercharged engines as well as to four-stroke engines with natural induction. The conventional definition of volumetric efficiency is "the ratio of the volume of air retained in the cylinder during the compression stroke to the displacement volume of air at normal pressure and temperature." Dr. Schweitzer said a volumetric efficiency so defined does not lend itself to use with Diesel engines, which always operate with an excess air factor, so that there is a certain amount of air in the residual gases. He has developed a formula for the brake mean effective pressure of Diesel engines involving the specific fuel consumption, the chemically-correct air/fuel ratio by

(Turn to page 56, please)

New Products for Aircraft



Motor driven tail light flasher mechanism.

Flasher for Tail Lights

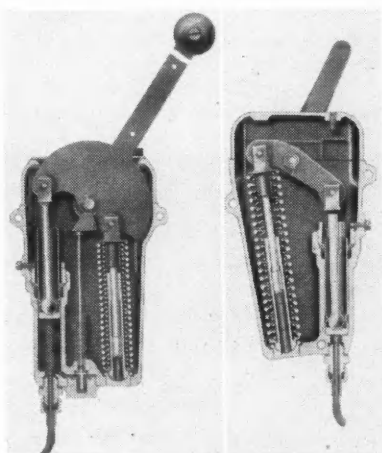
A governor controlled, motor driven mechanism for flashing the red and white tail lights of aircraft, is offered by Wallace & Tiernan Products, Inc., Belleville, N. J. The periods of light and eclipse for the 40 cycle per min flashing characteristic are held accurate by the governor controlled motor, which is unaffected by position, vibration, voltage variations, or temperatures between -35°C and 50°C . The power consumption is said to be less than 3 mls at 12 v. Lamp contacts have a snap break wiping action and will handle three 32 cp lamps on each circuit. The mechanism is enclosed in a moisture proof case and is approved by the C.A.A.

A New Model Sperry Exactor Hydraulic Control

To provide a positive means for the remote control of many types of equipment, Sperry Products, Inc., Hoboken, N. J., are producing their Type E Exactor Hydraulic Control. The control consists of two units, a transmitter fitted with a handle and a receiver which delivers through its lever whatever motion is imparted to the transmitter handle. A single tube is used to connect the transmitter and receiver. The tube can be bent to pass intervening objects and flexible connectors can be used where it is necessary to reduce vibrational effect on the tube.

The control operates on the fluid displacement principle; moving the handle of the transmitter through its arc causes a downward movement of the transmitter piston, forcing a definite quantity of oil to pass to the receiver, thus moving the piston of the receiver upward and causing the lever on the receiver to move through an equal arc. When the transmitter handle is returned to its original position, fluid is forced from the receiver to the transmitter by pressure of the spring on the receiver piston, returning the receiver lever to its original position.

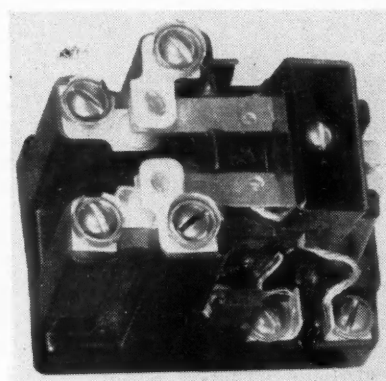
A single receiver unit can be controlled from several transmitter units situated in different locations and specially designed receiver units can be provided where the requirements of unusual applications demand modifications of the regular design.



Transmitter and Receiver of the Sperry Exactor Hydraulic Control.

Small Instantaneous Auxiliary Relay

An instantaneous auxiliary relay, type HMA, designed to meet the lightweight and small-space requirements of Army, Navy, and Air Corps specifications, is announced by General Electric Company, Schenectady, N. Y. The unit weighs 9 oz and is $1\frac{1}{8}$ in. by $2\frac{3}{4}$ in. by $2\frac{9}{16}$ in. with the cover in place. The base, cover and moving contact supports are of molded Textolite. Contacts are

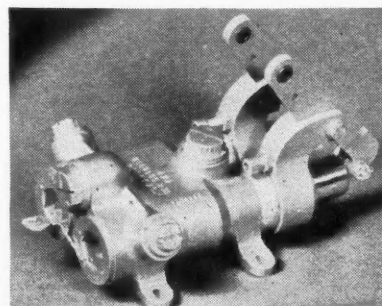


The General Electric type HMA relay.

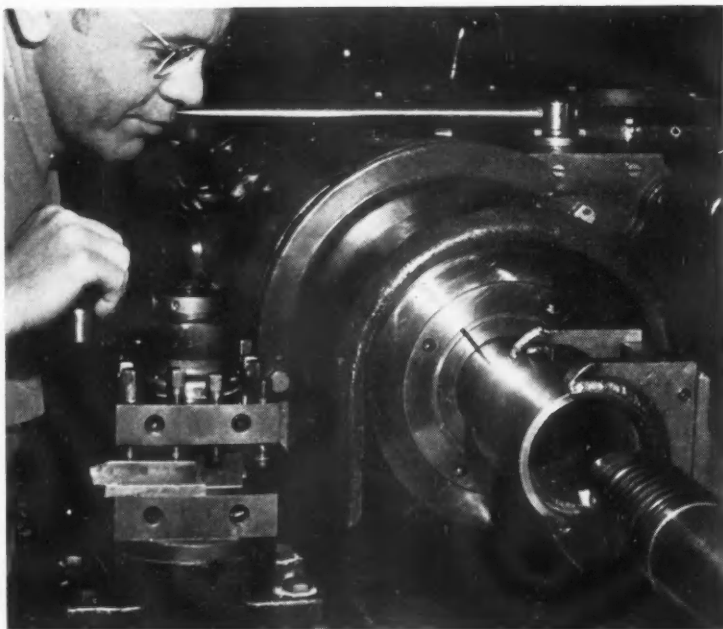
silver to silver, self-aligning, and will interrupt 1 ampere at 125 v d-c inductive load. The relay is available in the following styles: Double-pole, double-throw, with single-break contacts; single-pole, double-throw, with double-break contacts; single-pole, double-throw, with double-break contacts brought out to a terminal. It can be supplied back or front connected, with or without cover.

Light Weight Brake Valve for Airplanes

A simplified brake valve, for use in planes with gross weight in excess of 12,000 lb, has been developed by Aircraft Accessories Corporation, Burbank, Cal. It is designed for foot-pedal operation of brakes where the power is supplied direct to the brakes from the main
(Turn to page 74, please)



Aircraft Accessories Corp. brake valve.



North American's new boring tool originally was presented in the pictorial feature, *Production Short Cuts at Aircraft Plants*, which was published in the Oct. 15 issue of *AUTOMOTIVE and AVIATION INDUSTRIES*. This description, prepared by engineers of that company, is being published in response to numerous requests for more information as to its construction and operation.

New Tool Revolutionizes

Long Hole Boring

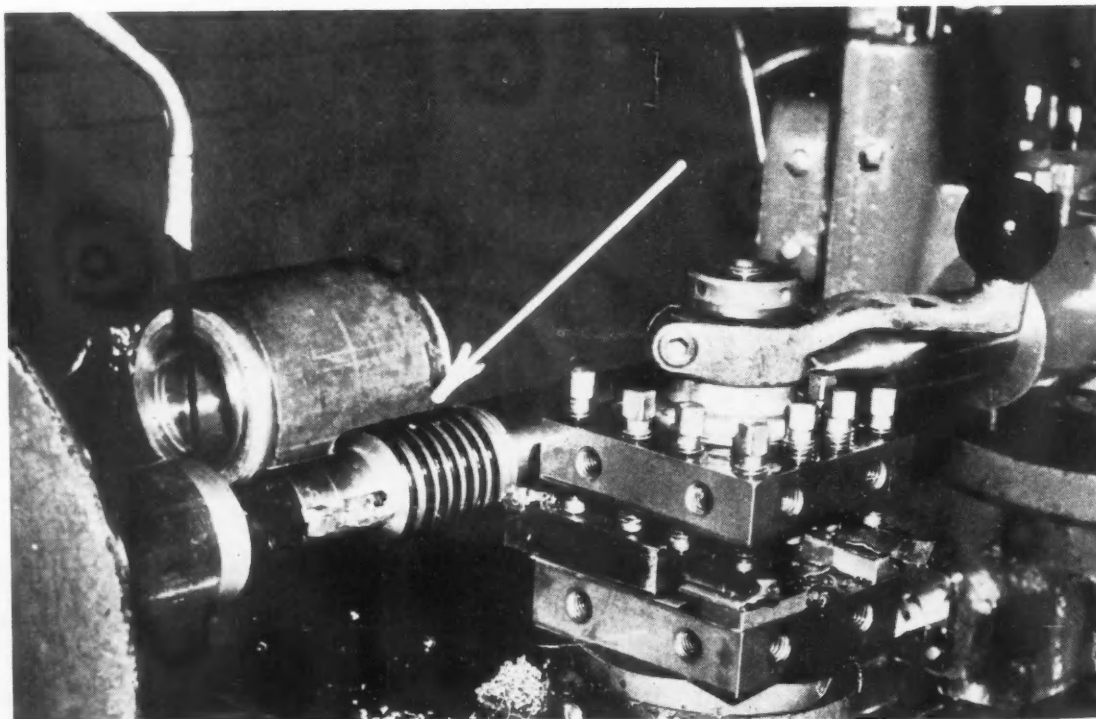
at North American Plant

A BORING bar, developed at North American Aviation, has proved to be an outstanding tool for boring long accurate holes, not blind, in tubing for such aircraft parts as landing gear, operating struts, flap struts, or any hydraulic cylinder type strut. Its extreme success in boring holes for any length with no variation in size proves that the cutters as well as the aligning device are well-balanced and properly designed.

Simple in construction, the tool has no cams or pivots to wear and get out of adjustment; and, in addition, the proportions are such that the bar is very rugged. Only occasional sharpening of the tool bits is necessary to assure satisfactory operation.

The bar consists of a piece of Shelby heavy-walled tubing, an Oilite housing to hold six No. B-1217N Neoprene rings, two hardened and ground thrust washers and one of Oilite, heads of different designs to hold either single carbide bits or double high speed bits, drilled to direct coolant against cutting edge of bit. A washer of Neoprene is placed between head and body of bar to prevent chips from reaching Neoprene rings. One machinist with 15 years of experience reported that he had never used anything that would bore as accurately or as fast in long bores as this boring bar. *(Turn to page 72, please)*

The "Caterpillar" boring bar, designed at North American Aviation, is exceptionally efficient in long hole borings.



New Production Equipment

BLANK AND BUXTON MACHINERY CO., Jackson, Mich., are offering an improved model Index milling machine. The table is fitted with verniers cross and longitudinal. Material 8 in. by 16 in. can be milled, drilled and bored either straight or at angles at a single setting. The spindle runs in precision ball bearings and has a No. 9 Brown & Sharpe taper hole. The spindle head swivels 90 deg right or left and the quill has 3 1/4 in. travel with power feed. Available speeds are said to be fast enough for 1/8 in. end mills and slow enough for boring 3 in. holes in steel.

PREVIOUSLY furnished with manually controlled, six station turret, the Oster No. 601 "Rapiduction" lathe, made by the Oster Manufacturing Co., Cleveland, Ohio, is now equipped with automatic indexing. The machine has

a capacity of 1 1/2 in. (round) for cutting-off, boring, tapping, reaming, facing, threading and other operations, and can be used to release more costly machines and highly skilled operators from a wide range of bar and chucking work.

Where fewer than four operations in sequence are required, the lathe can be furnished with a plain saddle instead of the six-station turret. The machine occupies 33 in. by 70 in. of floor space, not including the bar-feed extension, which requires 94 in. beyond the pan.

THE LATEST addition to the line of presses manufactured by The Hydraulic Press Manufacturing Company, Mount Gilead, Ohio, is a self-contained H-P-M FASTRAVERSE deep drawing press for sheet metal, equipped with blank-holder and die cushion for drawing large, deep metal airplane parts. A matched punch and die set is employed with this type of press. A ring, carried by the blank-holder slide, holds the blank while the part is drawn. Usually the part is completely drawn from a flat blank to the required shape in a single press stroke.

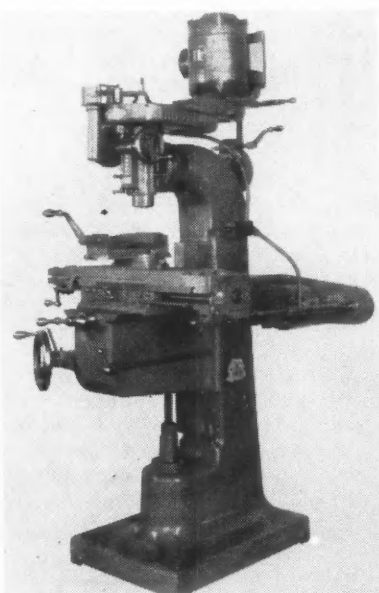
The press is of universal design and can be used to deep draw aluminum alloy, steel and other sheet metals. It will accommodate all standard types of deep drawing dies, or if required can be employed for single action press work such as coining, sizing or straightening.

The hollow press bed is fitted with an

H-P-M hydraulic die cushion. This die cushion can also be used as an ejector, when desired. Blankholder pressure is variable at six points on the periphery of the blankholder ring as the pressure resistance of each of the six blankholder rams can be adjusted individually and independently. A feature of this press is that only one hydraulic pump is required. Oil trapped in the blankholder and die cushion cylinders is intensified by the downward acting movement of the upper punch carrying slide. These intensified pressures produce the resistance forces necessary for holding the blank and cushioning the draw.

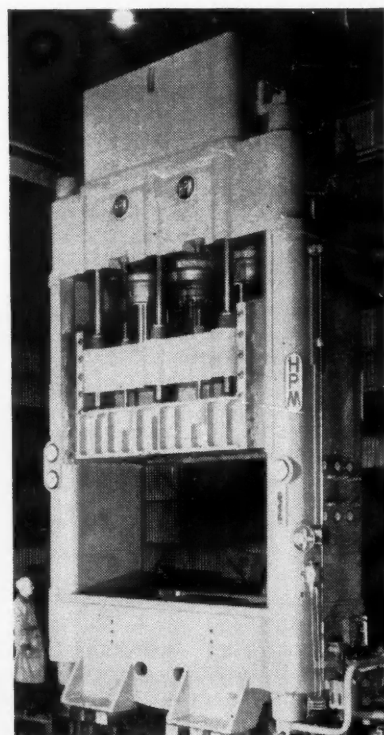
The H-P-M operating circuit is employed and press reversal is accomplished without the use of an operating valve by reversing the output of the pump. Means are provided to operate the press in any one of three different ways: Manual, semi-automatic or full automatic. Electric push buttons are provided.

(Turn to page 80, please)



The Index milling machine.

Oster No. 601 "Rapiduction" turret lathe.



The H-P-M Fastraverse deep drawing press.

Quality Control Plays a Major Role at Bendix

(Continued from page 23)

noteworthy for the many examples of improvisation, of adapting old equipment to specialized operations for which new equipment either has not been justified or not available.

A visualization of the parent plant operation will be found in the pictorial section.

BENDIX DIVISION (Michigan area)

In the interest of space economy, the high-lights of strut manufacturing will be given in connection with the new Bendix division which was set up for the manufacture of different strut assemblies, one of these being a mass-production layout with a specialized department for producing just one type in large quantities.

This plant, incidentally, is an excellent example of the utilization of an old unused automotive building which was re-habilitated for the purpose. It was reconditioned, well painted, equipped with modern fluorescent lighting. One of its noteworthy features is the general adoption of the well-known Bulldog power distribution overhead duct system which makes possible the arrangement or movement of production machinery at will with power hook-up simply by plugging-in into the overhead duct.

Consider the routing of an outer cylinder for a large strut assembly. The tubing is normalized and heat treated, shot-blasted in Pangborn cabinets, checked for hardness, and is ready for machining. First operation is that of turning the O.D. on a Monarch lathe; then chucking small end and facing and boring the large end on another Monarch lathe. There are a number of settings in Monarch lathes and on a Gisholt for boring the large end. The O.D. then is ground in several steps on Cincinnati Filmatic grinders. Internal and external threads are milled on large Lees-Bradner thread millers. Then with the cylinder held in a three-jaw chuck various inside diameters are ground on Heald internal grinders.

The O.D. on the packing gland end and a taper section are ground on Cincinnati grinders. Then the inside diameter is finish-honed on a big Barnes Drill Co. honing machine fitted with Micromatic hones. The part is washed, checked for surface finish on a Magnaflux machine, thus completing the initial stages of machining.

Next comes the welding of the upper fitting—a forging. The fitting is tack-welded in two places, using the Lincoln shielded-arc equipment, drilled and reamed in a heavy-duty Baker drill press, washed, burred, then returned to the welding booth for pre-heating and final welding. It is of interest to find that welding is done in a long row of

booths with normalizing after welding in a parallel row of R. C. Mahon annealing furnaces.

After shot-blasting to clean the weld, various holes are drilled, the fitting rough-milled on a No. 4 Milwaukee mill, then finish-milled on a similar machine. This is followed by milling of slots and drilling of detail holes, burring, etc.

All cylinders are inspected, subjected to a high pressure test for soundness. Following this, the assembly is Magnaflux-inspected with particular attention to the soundness of the forgings. Then the cylinder is suitably masked, cadmium-plated, and inspected.

It may be noted at this point that the plant boasts a large heat-treating department equipped with a battery of long Surface-Combustion pusher type continuous annealing furnaces, and Surface-Combustion end type radiant tube hardening furnaces. The cylinders are prepared for hardening by suspending them on hooks in a tree form.

Welding operations are carefully controlled by the Lincoln Electric Co., shielded arc method, and the process checked regularly by X-ray examination to assure soundness of welds.

A typical inner cylinder routing starts with heat treating and quenching of the tube, turning the O.D. on 3A Warner & Swasey turret lathes, boring the inside and facing on Libby lathes, rough-turning and finish-turning the O.D. complete in separate settings on Fay automatic lathes, rough- and finish-boring on Libby lathes. The O.D. is ground on a Landis external grinder, the bore ground on a Heald internal grinder, threads milled on Lees-Bradner thread millers. The cylinder then is burred, washed, Magnaflux-inspected, washed, and inspected.

The inner cylinder diaphragm assembly, consisting of the tube and assembled fittings is Magnaflux-inspected after assembly, pressure tested to 5500 psi, then ground on the O.D. on a Landis grinder. It is then chromium-plated on the O.D., and again ground, this time to final finish on a Cincinnati Filmatic grinder.

As mentioned earlier, the operations of turning and boring are done with Carboloy-tipped tools.

Speaking of the problem of maintaining quality control, it may be noted that certain operations have to be performed after final assembly to assure correct alignment. This is found in the case of the assembly of the inner cylinder with the fork and axle. Following preliminary assembly operations on the inner cylinder, a 0.250 in. hole is drilled then reamed in place on a Leland-Gifford drill. The fork tube and axle sub-assembly is pre-heated in an Ajax Electrothermic induction heater, then the inner cylinder is pressed in place. The

assembly is drilled and reamed for shear pins, which are later hand-reamed.

Some of the detail operations are unusually interesting. For example, the inner cylinder is rough-bored on a special vertical Baker drill converted for boring. The boring bar, tipped with cemented-carbide, is fed in from the bottom, moves upward to bore.

The metering pin, a long slender piece with numerous sections of different diameters and forms, is turned completely on a LeBlond lathe fitted with a Turchan automatic tracer attachment.

Outer and inner cylinders are bored on a large Gisholt with unusually long boring bars, fitted with cutters tipped with Carboloy.

Excellent example of the rigidity required in this operation is the set-up for milling lugs on one of the large fork forgings on a big Model K Milwaukee mill. The machine is fitted with large forming cutters, tipped with Carboloy. The heavy cut is taken with ease, without sensible vibration either in the machine base or work-holding fixture.

The Heald internal grinders are among the largest in use in any plant, have an unusually long stroke so as to handle bores in excess of 25 in. in depth.

At the parent plant cylinders are bored on the W. F. & John Barnes horizontal boring machines, mentioned earlier. These are of the same type as are employed for large gun drilling operations in ordnance plants.

The final assembly department combines many different operations, as may be noted from the routing mentioned above. In the assembly of the larger struts, while the fork and axle assembly is being induction-heated to accommodate the inner cylinder, the inner cylinder assembly is held suspended on an overhead hoist which also aids the operators in inserting the cylinder into the fork bore. On the average, the large fork forgings are heated for 5½ min before the proper and uniform temperature is attained.

Strut assemblies are made ready for shipment in the paint spray department. Here the struts—all varieties—are suspended on a closed monorail conveyor system for transportation to the spray booths. At the spray booth, a short separate section of the conveyor system is made slidable on rails leading directly into the booth, thus simplifying the handling problem. The paint is air-dried while the units move along on the conveyor from the spray booth.

Perhaps one of the most impressive sights in the machine shops is the roughing of large cylinders on the huge Fay automatic lathes. These are fitted with a multiplicity of tool blocks and upwards of 27 individual Carboloy-tipped tools are in action simultaneously.

The foregoing is but a brief word picture of a specialized art which has been developing over a long period of time but in which there has been little opportunity to develop mass-production techniques up to a short time ago.

Airplane Output Increased by Former Automotive Manufacturers

*Aiming at Goal of 100,000 Planes in 1943
Machine Tool Production at All-Time High*

Increasing acceleration of the aircraft procurement program with a view to attaining the 1943 goal of 100,000 planes is evident in the activity of former automotive manufacturers now turning out aviation equipment. Studebaker, Chrysler, Ford, Buick and Nash all have displayed real progress on their aircraft assignments in recent weeks.

Studebaker Corp. is the largest producer of aircraft engines on a unit volume basis outside the aviation industry, it was recently revealed by Harold S. Vance, board chairman. Studebaker is a major producer of 1,200-hp Wright Cyclone engines that go to power the Boeing Flying Fortress. Precision parts and gears for these engines are being manufactured in new Studebaker plants at Fort Wayne, Ind., and Chicago, while further manufacturing and final assembly takes place in a modern air-conditioned blackout type factory at South Bend. Fifty-eight per cent of the parts for these engines are obtained from subcontractors.

When the original contract was signed with the Army Air Forces Jan. 4, 1941, Studebaker was scheduled to

make another type Wright engine, a 14-cylinder job. Five months of planning and tooling had been completed

Apology and Copyright Credit

The extraordinarily fine detailed perspective drawing of the Avro Lancaster I Bomber which appeared on pages 30 and 31 of the Dec. 15 issue of AUTOMOTIVE AND AVIATION INDUSTRIES was reproduced from and is copyrighted by *The Aeroplane* of England. The drawing was made by Mr. J. H. Clark, whose outstanding work of this character appears regularly in our excellent and esteemed British contemporary.

As the result of a most unfortunate occurrence in connection with the printing of our Dec. 15 issue, the intended credit and copyright line was omitted. Our apologies to *The Aeroplane* for this omission are hereby extended.

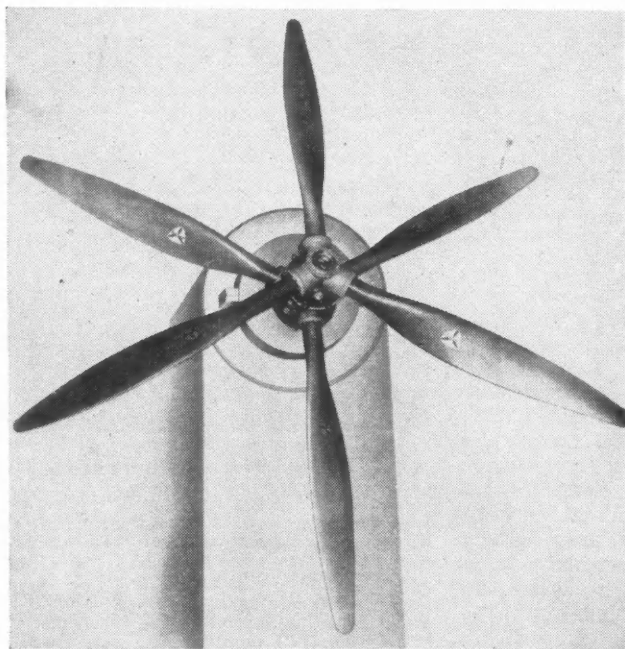
when the Air Force decided to concentrate on heavy long-range bombers as a result of tactical developments in Europe. With the heavy bomber program doubled, there was a prospective shortage of engines to power the B-17 planes to be produced by the Douglas-Lockheed-Vega pool as well as by Boeing. So in May, 1941, Studebaker scrapped five months of planning in order to change from the Wright 14-cylinder to the 9-cylinder engine. Only 10 per cent of the original tooling could be converted for use on the new type engine.

The new Studebaker aircraft plant at South Bend was completed in February, 1942, and the first pilot engine, composed 90 per cent of Wright-made parts, came off the assembly line the same month. Studebaker's orders were doubled after Pearl Harbor and the entire program advanced four months but the plant has been on schedule since last May. Studebaker engineers give full credit to the Wright Aeronautical Corp. for its aid in instructing supervisory personnel and helping overcome difficulties in the early stages of production.

The Defense Plant Corp. has advanced more than \$70 million to finance Studebaker's three new aircraft plants. On the basis of total employment, approximately 50 per cent of Studebaker's aircraft work is in South Bend, 30 per cent in Chicago and 20 per cent in Fort Wayne. Ninety per cent of the South Bend employees are from former automotive plants. Most spectacular manufacturing development is a battery of Greenlee cylinder head machines at South Bend which costs more than \$750,000, including tooling. These machines have 50 operating stations as they drill, ream, mill and tap the cylinder heads. Only seven operators are required. The steel cylinder barrel forgings come into the plant weighing 74 pounds but they are machined down to 17 pounds after a series of 38 machine operations. The rough forged crankcase weighs 178 pounds but in its finished state this is reduced to 39 pounds. Eight faces and two diameters are put on the crankcase in a single operation. The plant has 96 test cells.

The aircraft engine contract is one of Studebaker's 10 war assignments. These will result in 1942 sales of \$215 million compared to \$115 million in 1941 and \$166 million in 1923, Studebaker's biggest previous year.

Chrysler Corp. is rushing construction on another aircraft engine project, the huge Dodge Chicago plant, which will make high-output Wright Duplex
(Turn to page 50, please)



Dual Rotation Propeller with Hydraulic Pitch Control

The first six-bladed, dual rotation airplane propeller to be built as a self contained unit with its own hydraulic system. It is manufactured by the Aero Products Division of General Motors Corporation.

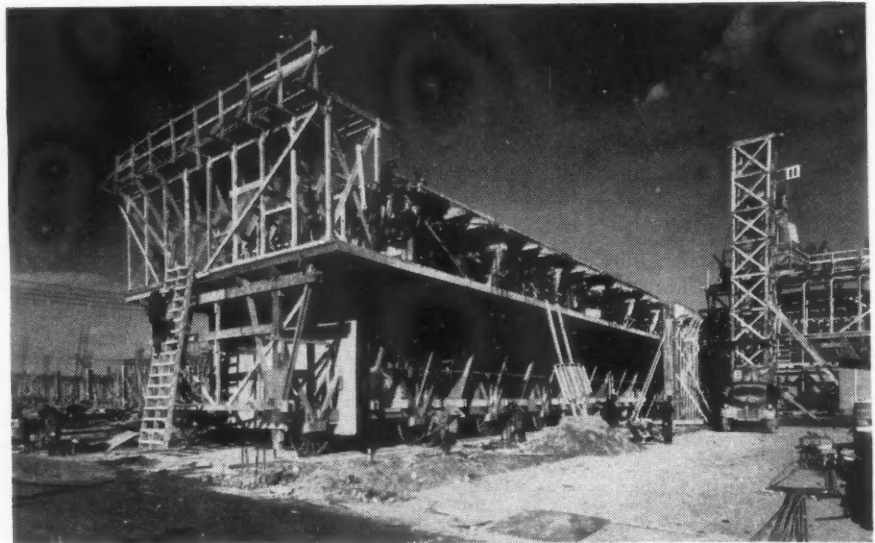
Resources Pooled to Aid Synthetic Program

Jesse H. Jones, Secretary of Commerce, has announced that Rubber Reserve Company has made a contract with National Synthetic Rubber Corporation for the operation of a new government-owned synthetic rubber plant to be built in Kentucky by the Defense Plant Corporation, a subsidiary of Reconstruction Finance Corporation. The plant's output will be made generally available and allocated by the government, together with the products of other government-owned synthetic rubber plants.

Formed for the specific purpose of operating the new government-owned plant, the National Synthetic Rubber Corporation is jointly owned by five long-established rubber companies which manufacture a wide variety of products ranging from motor car tires to coated abrasives and including scores of articles of vital importance to the war effort.

The five independent companies which participate in the ownership of National Synthetic Rubber Corporation are Goodall Rubber, Inc., and Hamilton Rubber Manufacturing Company, both of Trenton, N. J.; Hewitt Rubber Corporation of Buffalo, N. Y.; Lee Rubber & Tire Corporation of Conshohocken, Pa., and Minnesota Mining & Manufacturing Company of St. Paul, Minn.

National Synthetic Rubber Corpora-



Dodge Chicago Aircraft Engine Plant

Fifty-two of these concrete forms on wheels are being used on the construction of one of the fifteen buildings in the plant. After reinforcing has been laid and concrete poured and set, the forms can be moved to new positions in eight minutes

tion represents a significant cooperative move among the independent rubber companies as a result of the war and the loss of crude supplies from the Orient. They have pooled substantial amounts of capital and have provided from their organizations a technical staff of ability and experience for the management of the new synthetic rubber plant.

sion to the entire output of electric furnaces is a case in point, but the speeding up of the use of Bessemer steel in place of Open-Hearth steel, wherever this is possible, is another problem, which continues to receive attention. Substitution of steel for copper, a practice that is growing in many uses, while making for economy, adds to the steel demand.

Annual reviews failed to come in for the attention which they usually receive. The needs of to-morrow are so much more in the minds of metal producers and consumers than what happened yesterday. The War Production Board, in a review of 1942, placed the supply of copper from all sources at 3,000,000 tons, compared with about 2,500,000 tons in 1941. More than 600,000 tons of the 1942 supply came from the recovery of scrap. Under a recent WPB order, inventories of CMP materials, of which copper is one, must be held down to 45-day supplies instead of the 60-days' requirements previously permitted.

Latest word from the tin-mining districts of Bolivia is to the effect that a strike, which might have seriously impeded the flow of tin ores to the United

(Turn to page 48, please)

Closer Control of Materials Necessitated by New War Needs

Substitution of Steel for Copper Adds to Steel Demand; Inventories of CMP Materials Reduced

By W. C. Hirsch

"One of the biggest of home front jobs" is the way the Civil Service Commission referred to the Controlled Materials Plan in seeking competent production specialists to administer it. Steel producers and consumers, although so far having only a foretaste of the work entailed by CMP, are in hearty accord with the Civil Service Commission's characterization. Despite this, however, there is in evidence a genuine desire to co-operate in every way to expedite the necessary preliminary work and to give CMP, once it is in effect, a thorough trial. This is not merely the attitude of those who were "sold" on the plan when it was first presented, but also of those who still have doubts that it can be made to function. So far all methods for bringing steel production into balance with the Nation's war needs have proved more or less disappointing, and, be the work necessary to put CMP across ever

so voluminous and intricate, it is considered as well worth this cost, if its objective can be attained. Prime war contractors are reported to have been asked to schedule their steel requirements with specifications, so that they can be passed on to the proper claimant agencies. Not a day passes that closer control of this or that item on the metal list is not made necessary by the shift in war needs.

Complete control has now been established over production of carbon steel made in electric furnaces and shipments of this material. Formerly only alloy steels and iron came under such control. Tool steel control has been tightened, stepping up conservation of scarce alloying elements, such as tungsten, vanadium and molybdenum. It is no longer, however, the composition of steel that alone comes within the purview of the control authorities, but to this are now being added steel-making processes. Exten-

CALENDAR

Conventions and Meetings

- SAE War Engineering-Production Mtg., DetroitJan. 11-15
- Eleventh Annual Meeting of the Institute of the Aeronautical Sciences, New York City, Detroit and Los AngelesJan. 27, 28 and 29
- American Foundrymen's Association, St. Louis, Annual Mtg.April 28-30

AUTOMOTIVE and AVIATION INDUSTRIES



Automotive Picker Harvests Cotton Crop

Two of the new mechanical pickers developed by the International Harvester Co. The picking element consists of a box housing two drums, each containing a series of vertical shafts. On the latter a number of revolving spindles are mounted. As these gathering spindles enter the plant, they come in contact with the open cotton bolls and spin the cotton out without disturbing unopened bolls. Cotton is removed from spindles by rubber strippers, or doffers, and conveyed by vacuum to a separating chamber, thence by air pressure to wire-netting basket mounted on top of the machine.

MEN

F. L. Hopkinson, formerly associated with General Motors Corp., has been named vice president of Willys-Overland Motors, Inc. **William H. Schneider**, formerly comptroller, has been appointed treasurer.

George E. Strong, director of plant protection and publicity for the Central Air Corps Procurement District, has been promoted from lieutenant-colonel to colonel.

Frederick C. Crawford, president of Thompson Products, Inc., has been elected president of the National Association of Manufacturers for 1943. **Donaldson Brown**, vice chairman of General Motors Corp., has been elected a national vice president and **George W. Mason**, president of Nash-Kelvinator Corp., has been named a regional vice president.

George W. Kennedy, president of Kelsey-Hayes Wheel Co., has been elected a director of the Manufacturers National Bank, Detroit.

Harry S. Zane, Jr., vice president, has been appointed chairman of a new management committee to direct the operations of the Guiberson Corp. and the Guiberson Diesel Engine Co.

Bayard D. Kunkle, vice president of General Motors Corp., has been given the added responsibilities of group executive over the Cadillac, Oldsmobile, Pontiac, Canadian and Overseas divisions of GM. His assistant will be **W. S. Roberts**, formerly vice president and general manager of General Motors of Canada, Ltd. **William A. Wecker**, president and general manager of McKinnon Industries, GM subsidiary at St. Catharines, Ont., will succeed Roberts as vice president and general manager of GM of Canada. **Thomas Cook**, formerly factory manager, will become president and general manager of McKinnon Industries.

B. C. Heacock, chairman of the executive

committee of Caterpillar Tractor Co., has been appointed director of the priorities control division, Distribution Bureau, of WPB.

William H. Knight has been appointed director of sales and market research for Elastic Stop Nut Corp.

Kenneth E. Nighman has been appointed publicity director for the Detroit plant of U. S. Rubber Co.

John A. Gardner, traffic manager of Murray Corp. of America, has been elected president of the Traffic Club of Detroit.

Ezra W. Clark, vice president and general manager of the tractor division of the Clark Equipment Co., has gone to England on a special mission for the War and Navy departments and will visit bases in the European war theater.

T. Spencer Shore has resigned as director of the Industry Advisory Committee of WPB to return to his old position as vice president and treasurer of the General Tire & Rubber Co., Akron. He will continue as a consultant for the committee.

Roy Barbier, formerly advertising manager of the Ford Motor Co., has joined MacManus, John & Adams, Inc., Detroit, as contact man on the Cadillac account.

WPB has announced the formation of the Automotive Transportation Advisory Committee, composed of traffic managers of automotive companies. **D. C. Fenner**, of the Automotive Division of WPB, is the presiding officer. Members of the committee are **L. C. Allman**, Fruehauf Trailer Co.; **H. E. Boyer**, White Motor Co.; **J. J. Crimmins**, Studebaker Corp.; **Albert Crockett**, Mack-International Truck Corp.; **M. L. Gibson**, International Harvester Co.; **O. A. Johnson**, Ford Motor Co.; **C. R. Scharff**, General Motors Corp.; **J. P. Sexton**, Electric Auto-Lite Co.; **G. H. Ostermann**, Timken-Detroit Axle Co.; **W. C. Parker**, Diamond T Motor Car Co.; and **N. D. Hoke**, Chrysler Corp.

T. R. Farley, vice president of Caterpillar Military Engine Co., has been advanced to executive vice president.

(Turn to page 88, please)

Business in Brief

Written by the Guaranty Trust Co., New York, Exclusively for AUTOMOTIVE AND AVIATION INDUSTRIES

Relative stability of general business activity continues. The seasonally adjusted index of *The New York Times* for the week ended Dec. 5 declined to 133.7 per cent of the estimated normal, as compared with 136.7 for the preceding week and 133.8 a year ago. The index of *The Journal of Commerce*, without seasonal adjustment, for the same period advanced to 129.1 per cent of the 1927-29 average from 127.2 a week earlier.

Department store sales during the week ended Dec. 12, as reported by the Federal Reserve Board, were 16 per cent above the corresponding level last year, as compared with a similar excess of 10 per cent shown for the week before. For the period of four weeks then ended, the total was 13 per cent greater than a year ago.

Railway freight loadings during the week ended Dec. 5 totaled 759,621 cars, 2.2 per cent more than the number for the preceding week but 8.9 per cent below that for the corresponding period last year.

Electric power output during the week ended Dec. 12 increased more than seasonally to a new peak and was 13.3 per cent greater than a year ago, as against a similar excess of 13.7 per cent a week earlier.

Crude oil production in the same period averaged 3,881,150 barrels daily, 46,900 barrels above the figure for the preceding week but 134,750 barrels less than the average output recommended by the Office of the Petroleum Coordinator.

Average daily production of bituminous coal during the week ended Dec. 5 was 1,842,000 tons, as compared with 2,065,000 tons in the week before and 1,783,000 tons a year ago.

Engineering construction contracts awarded in the week ended Dec. 17 totaled 13 per cent more than the comparable figure last year, according to *Engineering News-Record*. For 1942 to date, the total is 58 per cent greater than the corresponding amount in 1941—with public work advancing 86 per cent, as against a drop of 53 per cent in private contracts.

Professor Fisher's index of wholesale commodity prices for the week ended Dec. 11 rose to 108.8 per cent of the 1926 average, after remaining at 108.5 for four consecutive weeks.

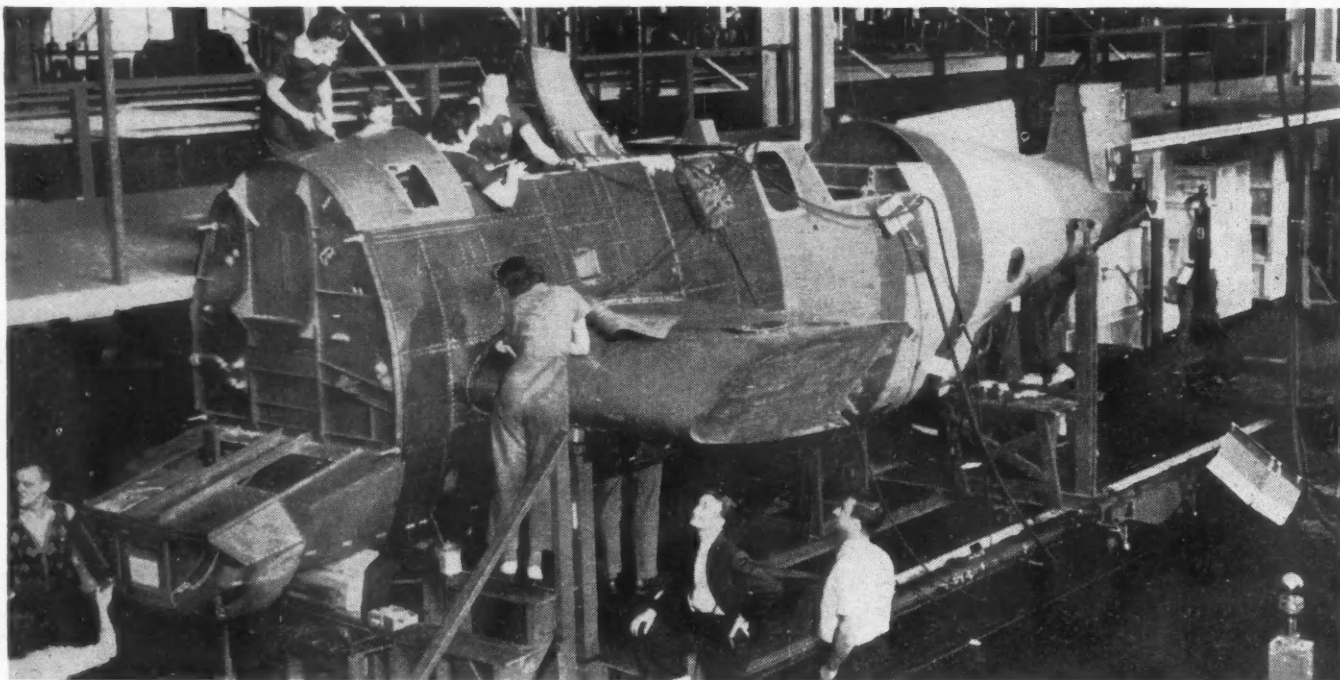
Member bank reserves rose \$250,000,000 during the week ended Dec. 16, but estimated excess reserves declined \$160,000,000 to a total of \$2,640,000,000. Business loans of reporting members fell \$35,000,000 in the preceding week and stood \$518,000,000 below the total a year earlier.

40 YEARS AGO

In general, the outlook for the year is bright. The capacity of the works which will supply the market in 1903 is large, but the demand for automobiles of all kinds will be large. President Scarritt, of the A.A.A., estimates that 35,000 vehicles will be sold during the year, and if this estimate be correct the manufacturers who know how to get their share of the business will certainly not be idle.

From *The Horseless Age*, Jan. 7, 1903.

General Motors Converts Five Plants to Warplane Production



This torpedo bomber fuselage is moving toward completion along the assembly line of the General Motors Trenton plant, which is one of five General Motors plants along the Eastern seaboard that have been organized as the Eastern Aircraft Division to build warplanes for the U. S. Navy. Two were formerly Fisher Body plants at Baltimore, Md., and Tarrytown, N. Y.; one the automobile assembly plant at Linden, N. J.; another the Delco-Remy battery plant at Bloomfield, N. J.; and the Trenton, N. J., plant was operated by Ternstedt for making automobile

hardware. L. C. Goad, formerly assistant to the General Motors vice president in charge Car and Truck Group, is the general manager of the Eastern Aircraft Division.

These five General Motors plants are now producing Wildcat fighter planes and Avenger torpedo bombers, both of which were designed originally by the Grumman Aircraft Engineering Corp. for carrier-based operations. The Wildcat fighter has been designated the FM-1 and the Avenger the TBM-1. The Linden plant has been

organized as a complete unit for manufacturing the Navy fighter and is the first automobile plant to be converted to complete aircraft assembly. The Avenger torpedo bombers are being assembled at the Trenton plant, most of the parts for them coming from the Baltimore, Bloomfield and Tarrytown plants. Conversion of the five plants was started in February, 1942, and this huge undertaking required that over 60 acres of floor space be stripped bare of its automotive equipment and retooled anew.

Increased Facilities for War Production Plants

Republic Aviation Corp. has been granted an increase in its contract with the Defense Plant Corp. of more than \$2,900,000 to provide additional facilities in Indiana, making the total commitment on this plant in excess of \$14 million. Boeing Airplane Co. has had its DPC contract boosted by more than \$1,800,000 for additional plant and equipment in Washington, making the total more than \$18 million.

General Motors Corp. has had authorized increases in three contracts with DPC. Additional facilities in Indiana and Michigan costing more than \$2 million have been approved, bringing the total commitment on this project in excess of \$63 million. Additional plant facilities in Ohio costing more than \$1,400,000 have been granted, upping the total to \$13 million, and additional equipment for a plant in Michigan to cost more than \$1,200,000 has been approved.

Hudson Motor Car Co. has been granted an increase of more than \$600,000 for facilities in Michigan, bringing the total to more than \$1 million. Ford

Motor Co. has been authorized \$250,000 for additional plant facilities in Michigan. Liberty Aircraft Products Corp., Farmingdale, L. I., has been awarded an increase of \$300,000, bringing total commitment in New York State to \$1,900,000.

Ex-Cell-O Corp. has had its DPC contract raised by more than \$450,000 for additional Michigan facilities that will cost more than \$8 million. W. F. & John Barnes Co., Rockford, Ill., has been granted \$100,000 for additional equipment for an Illinois plant, bringing the total in excess of \$1,500,000, and also has been granted a separate contract for \$150,000 for additional facilities in Illinois.

Rubber Laboratory Established in Brazil

The Government of Brazil is establishing several regional agricultural institutes, one of which is located at Belem, Para, in an effort to develop its natural resources to the highest point. Through the State Department, the Bureau of Standards was requested to assist the Brazilian Government in equipping the laboratory at Belem and

developing a research program.

Under a provision of an Act of Congress, which provides for the loan of technical experts to South and Central American countries, Norman Bekkedahl, of the bureau's rubber section, has gone to Belem, where he will serve as chief of the Rubber Technology Division of the Instituto Agronomico do Norte. He has, as his assistant, Fred L. Downs, former rubber research chemist on the staff of the American Steel & Wire Co. Before leaving the United States, Dr. Bekkedahl placed orders for the equipment to set up a modern rubber research and testing laboratory. When completed, it will be the only one of its kind serving the United Nations in the tropics and at the source of the rubber supply.

Closer Control of Materials

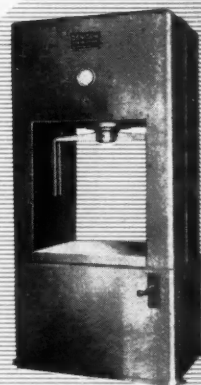
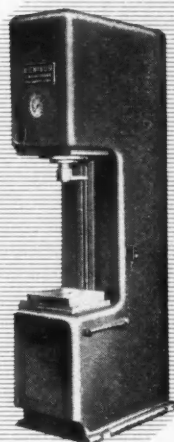
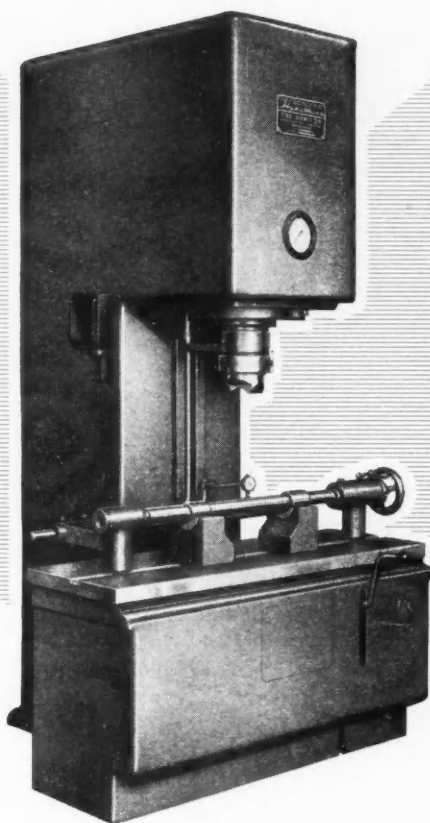
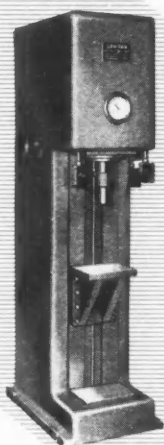
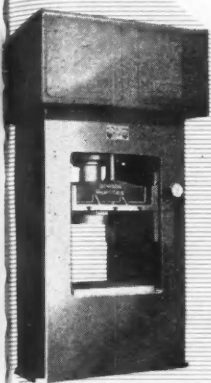
(Continued from page 46)

States, has been settled. It is pointed out that in discussing tin production and receipts of the metal in the United States WPB omitted to mention the contribution made to the U. S. tin supply by the Belgian Congo, which, according to the trade, exceeds in importance the yield of our scrap-dettinning plants.

AUTOMOTIVE and AVIATION INDUSTRIES

NOW AVAILABLE *in* 150-TON CAPACITY

HYDRAULIC PRESS FOR 15 to 150-TON
STRAIGHTENING *and* ASSEMBLING
DLSC2-150



Denison DLSC2 oil-hydraulic presses
have chalked up so many gains on so
many war-production jobs that a simi-
lar unit for heavier work has been
called for. So a 150-ton unit—the
DLSC2-150—has now been added to
the line of standard units.

Exact tonnage required for each task
obtained without adjustments . . .

Because the ram movement and pressure are both precision-
controlled by means of the hand lever or footpedal. (Yet stroke
and pressure limits can be set, if desired.) Release of the con-
trol lever returns the ram to the full-daylight or pre-set open-
ing at once . . . and positive locking prevents "drift".

DLSC2-150 is a fully-enclosed, self-contained press in
a streamlined frame, with ample toe-space. Maximum
stroke—12 inches. Maximum vertical opening—42

inches. Also available in 25, 50, and
100-ton units. Write for information.

OPERATION

Operation is simple. The ram is held in
place hydraulically when it reaches the
upper stroke limit, and the pump and
motor idle, using minimum horsepower.
Downward movement of the control

lever causes the ram to move downward at rapid travers
speed exerting minimum tonnage, until it contacts the work.
Further downward movement of the control lever increase
the tonnage in direct proportion to the pressure exerted on the
lever. Upon release of the control lever the ram returns
at once to the pre-set upper limit, or to the full-daylight
opening. All principal moving parts operate in a bath of
oil, reducing wear and maintenance costs.

THIS FREE BULLETIN may point the way to better results on
many assembling, straightening and bending operations
in your plant. It contains full details on the Denison line of
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DENISON
EQUIPMENT *in* APPLIED
HydroILic



Auto Makers Increase Airplane Output

(Continued from page 45)

engines for bombers. This plant will embrace an aircraft machining and assembly building many times larger than the Chrysler Tank Arsenal, two large foundries, two big forge shops, a heat treating and die shop, testing buildings, a tool shop and office building, the latter two already occupied, with 1,200 of Chrysler's engineering and production personnel at work. The large employment will require 23 plant cafeterias. More than 16,000 construction workers are building the plant, which is of a new type overhead arch-rib construction and reinforced concrete which economizes on steel. One hundred and fifty car loads and 800 truck loads of building materials are being used daily. The plant will house 6,000 machine tools and will require 4,300,000 bricks for outside finishing. The tool shop, already in operation, was completed in 94 days. The entire 15 buildings comprising the project will exceed in floor area the Ford Willow Run bomber plant.

The Willow Run plant has begun to deliver B-24 bombers to the Army Air Forces. Limited production has been under way for several months. By next March production is expected to reach three figures monthly and by the fall of 1943 peak production on the present program should be attained. Two hundred presses formerly used in automotive manufacturing have been converted to airframe work. Outstanding machine development is a \$400,000 Ingersoll milling machine that performs 20 operations on the center wing section within 30 minutes. One production team at the plant cut the construction time on the center wing sections by 53½ hours.

Buick Motor Division of General Motors has completed its first two contracts with the Army Air Forces for Pratt & Whitney 1,200-hp engines which power the B-24 bomber, among other planes. Constant increase of schedules permitted Buick to finish these contracts approximately a year ahead of the original completion dates. Schedules have been so expanded that they are now nine times larger than had been contemplated for the Melrose Park, Ill., and Flint plants. These increases will necessitate expanding the facilities of the new aluminum foundry at Flint, which was placed in operation last summer.

Nash-Kelvinator Corp. has completed its first Pratt & Whitney 2,000-hp engine at a former Nash automotive plant at Kenosha, Wis. The company is tooling up to turn out these powerful engines, used in the P-47 and the Grumman Corsair, in quantity.

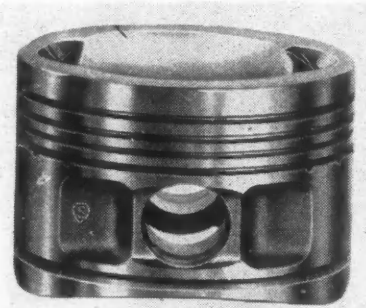
In another phase of the aircraft program, Mack International Corp. has vacated its Plant 5-C at Allentown, Pa., to make it available to Vultee Aircraft,

Inc., for the manufacture of torpedo bombers for the Navy. In thanking Mack for its cooperative spirit in moving its Army truck making operations elsewhere, C. E. Wilson, production vice chairman of WPB, said the move would save at least six months in the production of the Navy planes.

In his October report on war production, which showed overall production of munitions increased only 3 per cent from September, Donald M. Nelson, chairman of WPB, had some extenuating circumstances for the fact that October aircraft output was down 5 per cent from the preceding month on the basis of dollar value. Plane deliveries were bunched at the end of September and early in November, thus reducing October's total. Weather conditions that prevented test flights forced one manufacturer to delay delivery of 59 planes until after Nov. 1. Several much needed types showed increases, including Navy fighters, heavy bombers, two-engine fighters (P-38's) and one-engine light bombers. October aircraft engine shipments gained 4 per cent, about three-quarters of them for combat planes. Propeller shipments, a recent bottleneck, advanced 11 per cent.

Material difficulties resulted in only a 3 per cent gain in ordnance output in October. This limited the production of guns and tanks, medium tank output showing a decline, although light tank output advanced. Production of artillery and equipment for tanks rose markedly. Battle experience also has demonstrated that spare parts required for tanks and guns is greater than anticipated. Machine tool production in October displayed a marked rise, gaining 8.3 per cent to an all-time peak of \$130 million.

Permanent Mold Cast Tank Pistons



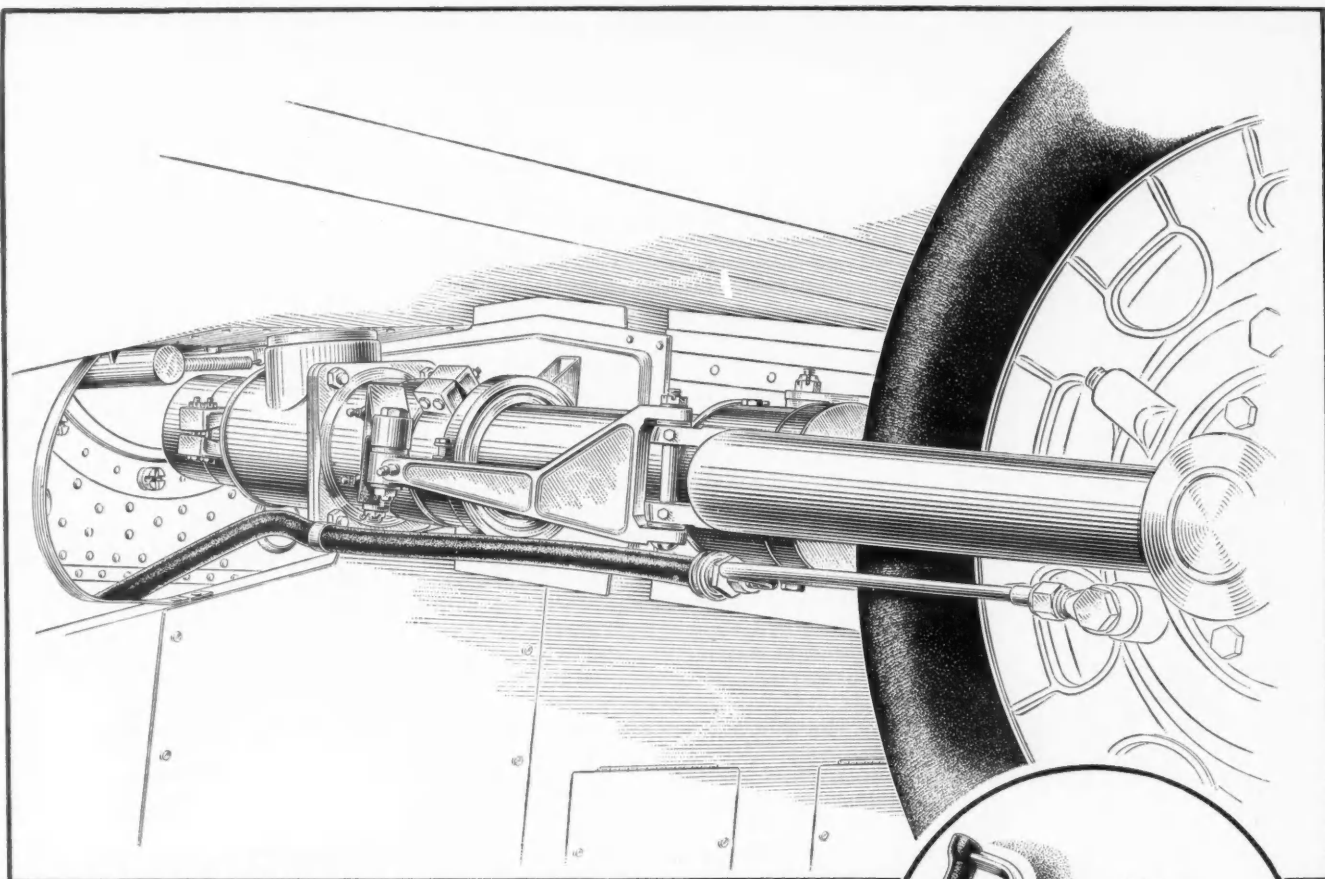
Sterling Aluminum Products, Inc., of St. Louis, pioneered in the making of aluminum pistons for tank and aircraft engines by a specially developed process of permanent mold casting using secondary alloys. These pistons have been adopted for Continental-Wright, Continental and Ford tank engines. One of the tank pistons is illustrated above.

Ford Motor Co. is producing anti-aircraft gun directors at a Detroit plant employing largely women. More than 2,000 women are working on this contract, which requires extreme precision work and tolerances of only 1/10,000 of an inch. These gun directors are able to direct the anti-aircraft fire at enemy planes with uncanny accuracy. Determined in advance are the wind direction and velocity, height above sea level and the distance of each battery of guns from the director. A range finder telescope on the director registers the horizontal and vertical distance of oncoming planes. The director mechanism automatically computes the dial setting for the guns and they are fired at a point where the fast-flying plane will meet the shell unless the plane suddenly changes its course.

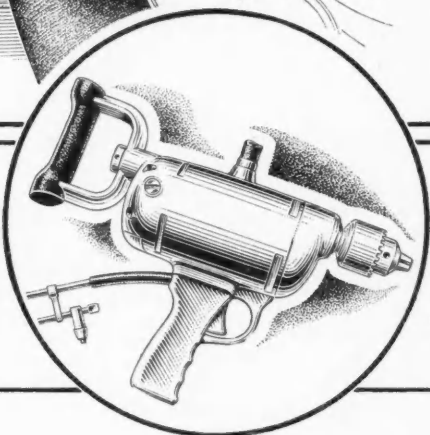


Air Ambulance for Navy Fliers

Top section of the after fuselage of this 100 hp. Piper litter ambulance is hinged to permit easy loading and unloading of injured men. Purchased by Navy recently, it can be flown quickly to the scene of a crack-up and ferry the injured to base hospitals.



what the Landing Gear Learned from the Portable Drill



IT'S A LONG WAY from portable tools to fighter planes—but an idea that works in one often proves just as good in the other.

That's the way it was with the Torrington Needle Bearing. Portable tool builders quickly saw how its unusual features could be used to cut excess ounces out of their product designs—where every ounce counts in conserving the operator's energy, in increasing his efficiency.

These same weight-saving features also caught the attention of the airplane designers. When they needed a bearing that would give easy operation to retractable landing gears...stand up

under the terrific impact when three tons of fighter plane hits the runway... and still meet the rigid weight requirements of fast, maneuverable aircraft, they found just what they wanted in the Needle Bearing's unique combination of low friction coefficient, high load capacity, and small size—plus its ready availability for war applications. That question of size is doubly important when it comes to weight economies. It means light weight in the bearing itself, of course. But much more important is the fact that housings and other parts can also be made smaller and lighter.

ISN'T THERE AN IDEA HERE FOR YOU TOO, as you get your post-war designs under

way? This light-weight trend looks increasingly important, with freight-by-air looming up as the coming means of shipment. While you're studying ways to conserve weight in your products, see how well the Needle Bearing fits into your problem. You will find the preliminary information you want in Catalog No. 107—and Torrington engineers will help you in adapting the Needle Bearing to specific applications.

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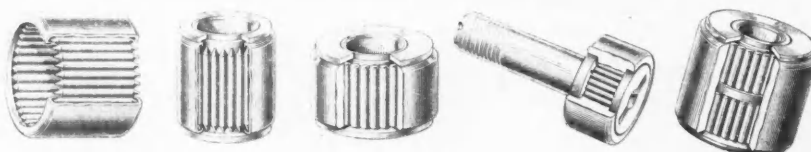
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TORRINGTON NEEDLE BEARINGS

KEYED TO TODAY'S NEEDS

AND TOMORROW'S TRENDS



Passes Along \$3 Billion Saving

(Continued from page 17)

original price. Original manufacturing time of 158 man-hours per gun was reduced to less than 81 man-hours.

These savings in cost and production time were achieved through skilled planning, introduction of progressive processing and assembly, and development of new machines, in cooperation with machine tool builders, which greatly shortened manufacturing time. Side plates originally milled individually were stamped on a punch press. Vertical reamers and drilling machines were installed to handle up to 12 gun barrels at a time. Electric riveting was substituted for the conventional cold hammer method, halving the production time on the riveting operation.

Citing this manufacture of machine guns as typical of efficiency on war assignments, Alfred P. Sloan, Jr., board chairman of GM stated, "In past years the energies of American industry were focused on the development of a peace-time technology for the production of civilian goods; there was very little demand for war materials. Consequently there had not been developed techniques for the intensive mass production of war materials that is now required. What is taking place is the application of management skill and experience, gained from peace-time production for consumers, to the problems of turning out vitally needed implements of war. This, together with the application of newly developed methods, is creating a new technology of war production."

GM has effected similar savings on other war goods. Pontiac Motor Division redesigned the shoulder rest and hand grips for a 20-mm anti-aircraft gun, not only making the equipment more adjustable for the gunner, but bringing a saving of \$45 per gun. Oldsmobile Division, by substituting Armasteel castings for forgings in parts for a 20-mm aircraft cannon effected the following savings: \$3.42 per gun on the buffer housing, \$3.87 on the magazine slide, \$2.80 on the muzzle brake ferrule, and an estimated \$1.40 on the sear cover plate. By rearranging machinery for making bolt subassemblies on the 30-mm machine gun, Saginaw Steering Gear Division increased production 245 per cent per man-hour. The same division saved 17 cents per gun by substituting steel stampings for seamless tubing in the front barrel bearing bands and plug locks. Another GM division saved 880 man-hours per month by electric seam welding cylinder sleeves for Allison engines instead of forming them by a draw operation.

When Packard placed its marine engine for the Navy in experimental production, it cost nearly \$30,000. After regular production started, the price was cut 9 per cent and with volume constantly being stepped up, there have been five further price reductions

amounting to more than \$10,000 or 37 per cent of the starting price. Packard likewise has accelerated its output of aircraft engines 600 per cent in the last year with appreciable savings to the U. S. and British governments. An automotive parts company pioneered in adapting a foreign-designed aircraft cannon for U. S. mass production methods. Although its original bid price of \$1200 per gun on the contract was half that of competitive bidders from other industries, this was cut to \$950 in six months and the current price to the government is 40 per cent lower than originally. An automotive manufacturer of bombers saved 75 per cent in man-hours on a wing panel operation and reduced the cost by \$1000 per set of wings.

Power Driven Factory Sweeper

The Moto-Mower Co., Detroit, Michigan, has developed a power-driven floor sweeper, called the Moto-Sweeper, which is an adaptation of their power driven lawn mower, in fact it can be converted easily into a lawn mower. The sweeper is equipped with a built-in water spray which is designed to just lay the dust without wetting the floor. Controls on the handlebar enable the operator to steer the outfit under its own power.

PUBLICATIONS

Westinghouse Electric & Mfg. Co. has brought out a new booklet on A-C welding describing and illustrating the **Flexarc A-C Welders**. The booklet compares the advantages of a-c and d-c welding.*

Three new technical bulletins have been issued by the Baldwin Southwark Div. of The Baldwin Locomotive Works. One describes the **SR-4 Strain Gage** (Bulletin No. 164) and the other two (Bulletins Nos. 169 and 170) the **recording and indicating instruments** for use with the SR-4 Strain Gages.*

A handy **calculator** that works like a slide rule has been prepared by the General Electric Co. to show at a glance how much copper can be saved in a war-plant electric power system by installing unit substations at the centers of the load areas. The reverse side of the rule carries a chart showing the per cent increase in cable copper as the voltage is decreased and another chart, gives the cable copper needed to carry a 1000-kva. load at various voltages over distances from 10 to 1000 ft.*

The Udylyte Corp. has issued a booklet on the subject of **hard chromium plating** which should be of great interest to all metal working establishments. Udylyte will be glad to cooperate with manufacturers in spreading the **know-how** of the technique wherever it can be of most assistance.*

South Bend Lathe Works has prepared some helpful material for training lathe operators. It is circular **No. 21-C on books and films on lathe operation** giving brief descriptions of the various motion picture films, instruction books, bulletins, wall charts and blue prints on lathe operation.*

The November issue of *Ceco Sparks*, pub-

lished by Chambersburg Engineering Co. is devoted to the 45th anniversary of the company. An article by Eugene C. Clark, president, traces the history of the company from its beginning in 1897.*

The November issue of *Institute Spokesman*, published by National Lubricating Grease Institute contains an article **Low Temperature Characteristics of Greases**, and one on the **Flow Characteristics of Lubricating Greases**.*

A new folder by Zagar Tool, Inc., is entitled **The Zagar Collet Chucking Fixture**, a Universal device for indexing or holding work on machine tools. In addition to describing and illustrating the models, instructions for setting up and operating the **Indexing and Holding Collet Fixtures** are included.*

*Obtainable through editorial department, **AUTOMOTIVE and AVIATION INDUSTRIES**. Address: Chestnut and 56th Sts., Philadelphia. Please give date of issue in which literature was listed.

ASA Holds Meeting, Elects Officers

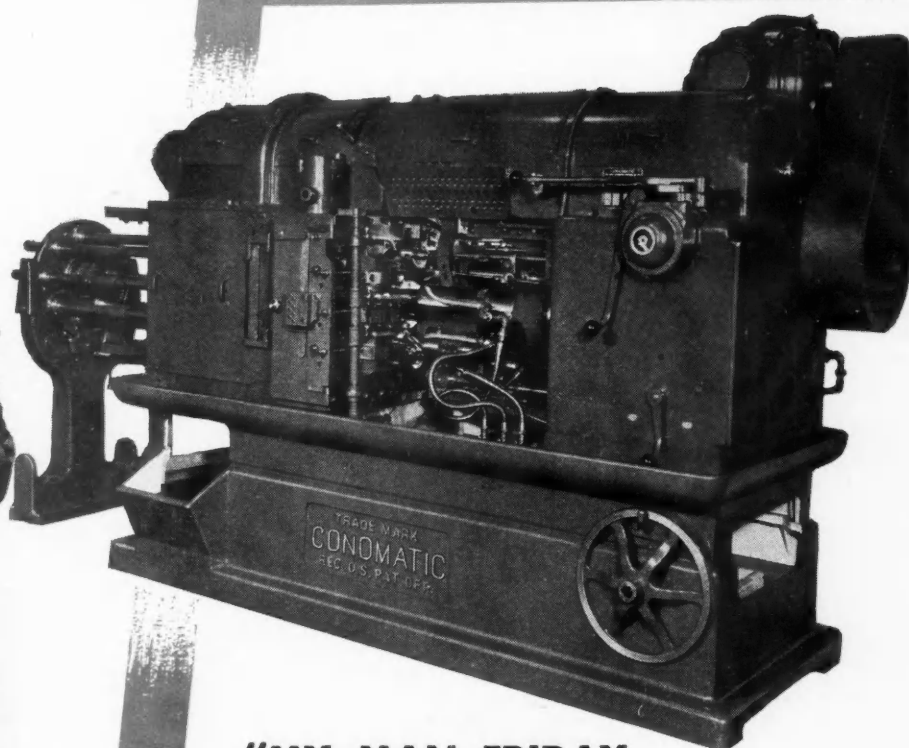
The American Standards Association, like many another business organization, has set a new production record for 1942. R. E. Zimmerman, President of the Association, reported at the annual meeting of the association held at the Hotel Astor, New York. Work in the past 12 months, all of which has tied in closely with the country's war effort, has resulted in 73 new standards and 49 revisions of existing standards. In addition, the association completed 10 American War Standards requested specifically by WPB, OPA or some other governmental agency.

Joseph L. Weiner, deputy director of the WPB Office of Civilian Supply, who was guest speaker at the meeting, outlined for members of the ASA how the Government's concentration policy is being followed, why it was adopted and how it is likely to affect civilian production.

At the election of officers for 1943, R. E. Zimmerman, vice-president of the U. S. Steel Corporation, was re-elected to serve a third term as president of the ASA. George S. Case, chairman of the board, Lamson and Sessions Company, was elected vice-president; H. S. Osborn, American Telephone & Telegraph Company, was re-elected chairman of the standards council, and E. C. Crittenden, National Bureau of Standards, was elected vice-chairman. The following organizations were elected to fill vacancies occurring on the board of directors: American Petroleum Institute, American Gas Association, Fire Protection Group, Association of American Railroads and American Institute of Electrical Engineers.

Synthetic Rubber Experts To Get Data in Russia

A four-man mission to Soviet Russia to collect both chemical and engineering experience on the manufacture of synthetic rubber has been appointed by William M. Jeffers, rubber director. Russia has had 10 years' experience in synthetic rubber making.



"MY MAN FRIDAY ... Every Day in the Week"

More pieces faster, in less time with less space and waste.

Wide ranges of feed and speed.

Heavy, rigid slide supports for heavier forming cuts.

Cams on one camshaft above working area — free from falling chips, oil and grit.

Tooling area, cams and controls convenient to operator from either side of the machine.

It pays to specify Cones; wire, phone or write for particulars.



4, 6 and 8 Spindle Automatic Bar Machines

CONE AUTOMATIC MACHINE CO., INC.
WINDSOR, VERMONT, U. S. A.

Ryan Develops Plywood Trainer

(Continued from page 25)

skin. Wings are built of aluminum alloy longitudinal stringers, shear beams and bulkheads, to which is flush-riveted an aluminum alloy skin. Ailerons are fabric-covered aluminum alloy frames, and there are trailing edge flaps. Fixed tail surfaces are of full cantilever design. They incorporate sheer beams and bulkheads and a flush-riveted aluminum alloy skin. Movable surfaces are fabric-covered aluminum alloy frames.

The monocoque fuselage of the new PT-25 primary training plane has 10 bulkheads formed of laminated spruce and a stressed skin of plywood. In cross section it has a wide, curved bottom (nearly flat) tapering to a more sharply rounded upper section. Wings meet the fuselage at 90 deg. eliminating the necessity of fairing. Ample reinforcement is obtained at the cockpit cut-outs through the use of heavy wooden longitudinal members extending from forward of the front cockpit to the rear of the rear cockpit. Straight lines are used in the center portion of the fuselage and in the tail cone, completely eliminating double curved surfaces.

The main bulkhead, No. 3, is made in three parts, and is slotted in the lower half to receive the center-wing spar. No. 2 bulkhead uses black walnut inserts every other lamination as this bulkhead carries the torque tube which joins up the leading edges of the outer wing panels. No. 1 bulkhead has black walnut plates at the four engine mount points, and the engine mount fitting makes use of a split longeron to carry the engine load back through the fuselage.

A unique geodesic fuselage jig instead of the usual beam type jig was perfected by the Ryan plant to speed up production of the fuselage sections.

The full cantilever wings have a two-to-one taper ratio and a 5-deg dihedral, and employ different NACA airfoils at the root and at the tip. A sturdy monospar wooden center section is used. The two outer panels have removable tips for ease of repair, maintenance and replacement. Each panel is built up from a single wood spar with wood ribs and a plywood covered nose torque box, with fabric covering the entire panel. In this respect it is the Ryan S-C wing, with wooden materials substituted throughout for metal. This type of construction makes possible a wing which has its natural center of gravity coinciding with the center of pressure and eliminates the probability of wing flutter. Spars taper in depth from root to tip. Root ends of spars are reinforced with hardwood blocks at the center section juncture and are attached at four points at the root of the spar and one at the leading edge. Walkways are located on both inboard portions of the center section and are adequately reinforced. All ribs, spar flanges and spar assemblies are brought to size from contour templates by means of

routers and shapers thus eliminating hand finish work and assuring accuracy with speed.

The fixed surfaces, stabilizer and fin, are fabricated from wood spars and wood ribs, and are plywood covered. The rudder, elevator and ailerons are made from wood spars and ribs, and are fabric covered. The center section flap utilizes a wood spar and ribs with plywood cover.

The landing gear, supplied by Pacific Aviation Products, is full cantilever with the welded truss assembly bolted to the center section spar. No fairings are necessary. Hayes wheels and hydraulic brakes are standard equipment. Oleo shock absorbers with long travel are used. All moving parts incorporate large bearings. The eight-inch smooth contour tail wheel is mounted on an Oleo shock absorber and is steerable from both cockpits.

Exterior access to the battery compartment is provided by means of a hinged panel just aft of the rear cockpit. The baggage compartment is accessible from the rear cockpit by means of a hinged section which opens forward at the head rest. Night flying equipment includes landing lights, navigation lights and latest type instrument panel illumination.

Little special equipment is required in building the new Ryan plywood trainer as cold-setting urea formaldehyde glues are used. The only molded plywood section is the leading edge of the outer wing panel. Standard size flat plywood sheets are employed for all other parts of the airplane, and since all shaping of the fuselage and other units is done over large radii, no complex forms are required for fabrication. The phenol formaldehyde resin-bonded processes enter into the manufacture of the Ryan plywood trainer only indirectly since this work is done by the supplier of the flat plywood sheet.

Metal fittings where necessary are of simple welded sheet steel and steel tube but the Ryan company is already conducting research work which may later make it possible to convert most of the secondary structures to plastic materials.

The six-cylinder horizontally opposed in-line air-cooled Lycoming engine develops 185 hp at 2550 rpm at sea level (Its model designation is O-435-1). The first one of the new ST-4's to come out of the plant is equipped with a Sense-nich fixed-pitch wood propeller, although the standard installation is to be a Wickwire Spencer two-blade automatic variable pitch propeller. An Eclipse electric starter and Eclipse generator are installed.

The fuel system consists of two "plastic" tanks located in the center section panel in plywood cells, with a total gasoline capacity of 27 gal. The oil is car-

ried in the engine crankcase. Fuel may be drawn from each tank by the engine driven fuel pump. A hand pump is provided for starting or emergency use.

Ailerons are statically balanced, and the right unit has a tab, adjustable on the ground. The angular movement is 25 deg up and 25 deg down. The rudder has a 35 deg movement in both directions and is provided with a fixed trailing edge tab for directional balance. Ball bearing hinges are incorporated throughout the moveable control group.

The horn balanced elevator has an angular movement of 35 deg up and 25 deg down. An elevator tab, operated from either cockpit, is provided. The adjustment is positive and any desired setting may be obtained. Ailerons are actuated by flexible control cable from the control column horns through pulleys to the aileron horns adjacent to the center hinges. The perforated center-section air brake is operated from either cockpit by means of a small electric motor, and has a 75 deg maximum lowered angle.

Complete dual controls and dual instruments are installed. A torque tube mounted on ball bearings connects the two sticks for aileron control, and flexible control cables provide the interstick connection for the elevators. The parking brake is controlled from the rear cockpit. Toe brake action is provided and rudder pedals are adjustable. Three-section military type windshields are used.

The standard dual instrument group includes: airspeed indicator, bend and turn indicator, rate and climb indicator, altimeter, clock, compass, tachometer, oil thermometer, and oil and fuel gages.

Crew protection in case of turnover as the result of training operations is provided for by a streamlined steel turn-over post bolted to the center section spar. Heavy wooden floor members are provided for the attachment of seats and controls. In addition to the usual safety seat belt, the PT-25 is equipped for shoulder straps in both cockpits for advanced aerobatic training. A blind flying hood may be installed.

The power plant installation has been planned to facilitate engine change and overhaul. The welded steel tube engine mount is attached to the fuselage structure with large bolts. A stainless steel firewall separates the engine compartment from the fuselage. Engine cowling is one of the few parts made of sheet metal stampings, and is readily removable. It has quick detachable fasteners and is divided into sections for general inspection or entire removal when necessary. All engine accessories are readily accessible. A Lunkenheimer fuel strainer and PESCO fuel pump are installed. Standard equipment includes fire extinguisher, flight report holder, aircraft data case, speaking tube, check list holder and cockpit cover.



YOU CAN RELY ON LYCOMING AIRCRAFT ENGINES

Thousands of mothers, the country over, express confidence in America's training planes . . . confidence built upon the fact that their sons have safely come through hundreds of hours of intensive flight training in these ships.

The steady, dependable operation of Lycoming engines has played a great part in assuring the safe flying that is inherent in America's training planes.

The Navy Spartan Trainer, shown above, is one of many Lycoming-powered planes used in training America's pilots . . . pilots who through long experience acclaim Lycoming to be the synonym for dependability in both military and civilian aviation.



Contractors to the
U. S. Army and Navy



THE TRAINING PLANE
ENGINE OF TODAY...
THE PRIVATE PLANE
ENGINE OF TOMORROW

LYCOMING DIVISION, THE AVIATION CORPORATION

WILLIAMSPORT, PA.

Mechanical Engineers Discuss Diesels

(Continued from page 40)

weight, the excess-air factor, the volumetric efficiency, the residual gas in the cylinder charge, and the piston-displacement volume, and this formula shows the b.m.e.p. to increase with an increase in the volume of residual gas. In other words, the poorer the scavenging the higher the power output. To avoid this inconsistency Dr. Schweitzer proposes a new definition for volumetric efficiency, namely, the ratio of the sum of the volume of fresh air retained in the cylinder and the vol-

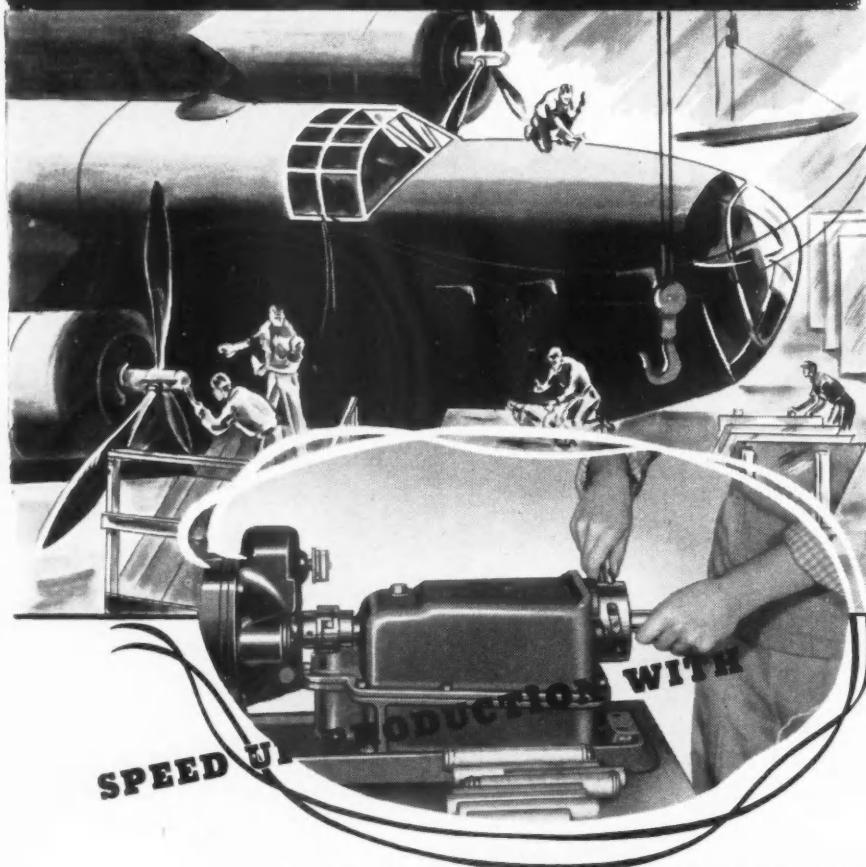
ume of residual gas in the cylinder charge to the piston-displacement volume of air, all at normal pressure and temperature.

Efficiency of Roots-Type Blowers

FREDERICK A. HIERSCH of the University of Michigan proposed a correction factor for the efficiency of Roots type blowers to take account of the heat transfer from the delivery to the suction side of the blower due to air

leakage or slip. In a Roots blower, when the ratio of the discharge to the inlet pressure is increased, the temperature rise of the air usually is greater than the pressure rise would lead one to expect. This is due primarily to the fact that air heated by initial compression slips from the discharge side of the rotors back to the intake side, where it mixes with the intake air at constant pressure and increases the temperature thereof. This mixture of slip-page air will be compressed and discharged during the second revolution, and a percentage of the mixture will slip back and be compressed during the third revolution, etc. The correction is made by changing the value of the exponent in the compression equation.

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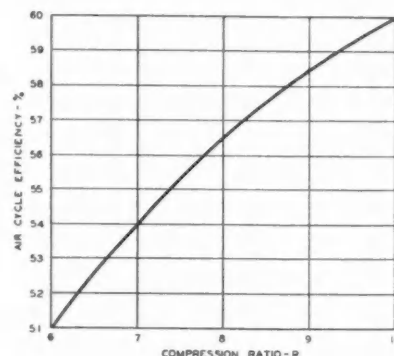
THE WAYNE PUMP COMPANY
FORT WAYNE, • INDIANA

Possibilities of Carburetor-Type Aircraft Engines

EQUATIONS for the calculation of the brake horse power per cu in. piston displacement per minute, the minimum octane number of fuel required to prevent detonation at this output, the specific fuel consumption and an excellence-of-design factor were given in a paper by G. P. Toews, project engineer of the Naval Aircraft Factory, Philadelphia. These equations, the author said, have been used for some time in checking the performance obtainable from four-stroke, air- and liquid-cooled aircraft engines and have been found satisfactory for engines with bores of 4 to 6 1/8 in. inclusive. They are not intended to apply to specific fuel consumption values lower than the "lean limit," but give correct results for richer mixtures up to about 0.9 lb per bhp-hr. The equations referred to are as follows:

$$Z = \frac{P \times E_1 \times E_2 \times E_3}{72.3 \times T}$$

where Z is the brake horse power per cu. in. of piston displacement per minute; P, the absolute pressure in the inlet manifold on the discharge side of the blower; E₁, the mechanical ef-



Variations of air-cycle efficiency with compression ratio.

iciency, which may be calculated from the maximum bhp desired and the friction hp measured on the dynamometer

LADISH

quality

DROP FORGINGS

ON EVERY BATTLEFRONT

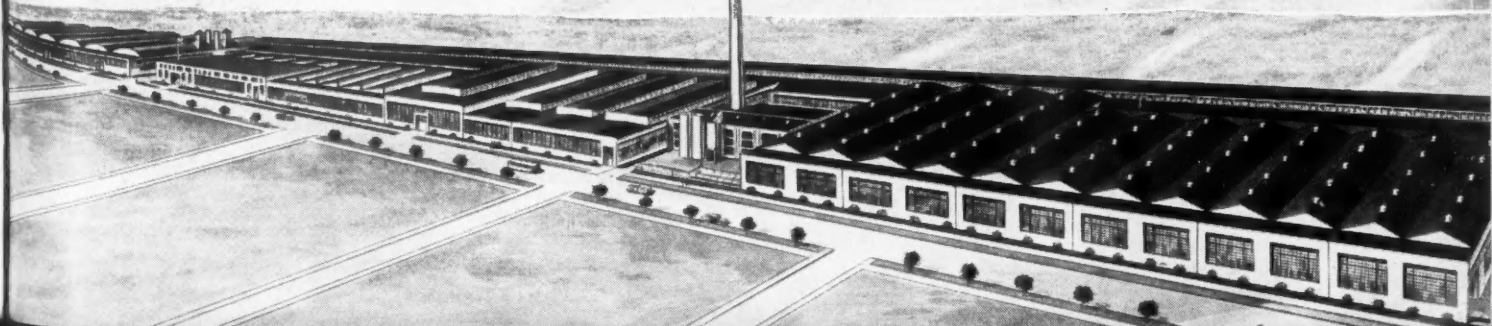
LADISH DROP FORGE CO.

PLANT AND GENERAL OFFICES

CUDAHY . . . WISCONSIN



TO MARK PROGRESS



at the end of the run-in period of the first model to be completed; E_s , the air-cycle efficiency given by the equation

$$E_s = 1 - \left(\frac{1}{R} \right)^{0.4}$$

where R is the volumetric compression ratio (see chart); E_s , the intake-valve efficiency given by the equation

$$E_s = \frac{W \times 1728}{V_d \times N \times 30 \times d}$$

where W represents the rate of air flow into the engine in lb per hr, which can be measured during the friction run on a dynamometer;

$$d = \frac{1.325P}{T}$$

where P and T are the absolute pressure and temperature of the air, which can be measured during the friction run; N , the engine speed in rpm, and V_d , the engine displacement volume in cu. in. The temperature T should be measured on the discharge side of the supercharger, with a shielded thermometer or thermo-couple.

The octane number, as determined by the CFR aviation test method of aviation-grade gasoline, which is required to prevent detonation when the engine is delivering an output Z is given by the equation

$$O = \frac{7379 \times Z \times T_i}{C^{0.82}}$$

so that

$$C = \left(\frac{7379 \times Z \times T_i}{O} \right)^{1.25}$$

The maximum bhp of the engine is

$$BHP_{max} = \frac{Z \times V_d \times N}{2}$$

The specific fuel consumption at maximum power without detonation is given by

$$C_{min} = \frac{0.232}{E_1 \times E_2}$$

No value of C lower than that of C_{min} should be used in the equation for the octane number of fuel required to prevent detonation.

For the "excellence-of-design" factor the author gave the following equation

$$F = \frac{E_1 \times E_2 \times E_3}{T \times O \times C \times w}$$

In the paper the application of these formula to actual engines was discussed and the following conclusions were drawn (among others):

Preignition caused by hot spots in the engine is not affected by the grade of fuel used and therefore need not be considered in rating tests of fuels.

A suitable value for the "excellence-of-design" factor F should be included in all engine specifications.

A high mechanical efficiency is best obtained by suiting the clearances of moving parts to the method of cooling, by eliminating oil churning, by eliminating causes of excess friction in bearings, and by lowering the manifold pressure P .

Higher compression ratios, up to 10 to 1, are necessary, and if used will necessitate higher ignition voltages.

An intake-valve efficiency of 1.20 or more, if possible, should be used in all military aircraft engines.

The lowest possible manifold temperature T is very desirable. This temperature can be lowered by using fuels of high heat of evaporation, by reducing the temperature rise in the supercharger, and by increasing the cooling effect on the supercharger housing and discharge ducts.

A 25 per cent decrease in the value of T (the absolute temperature) will permit of a 42 per cent decrease in C (the specific fuel consumption) or a 12 per cent decrease in the octane number of the fuel required.

Aircraft engines employing fuel injection in place of a carburetor may operate satisfactorily on fuels of lower octane value, due to the lower mixture temperature at the beginning of compression.

Rubber Compounds for Shear-Type Machinery Mountings

THE effectiveness of shear-stressed rubber compounds in isolating machinery vibration was dealt with in a paper by Baxter C. Madden, Captain,

"Converted" TO SERVE OUR Converted CUSTOMERS

• Wartime conversion of automotive plants found The Dole Valve Company already converted to the same program.

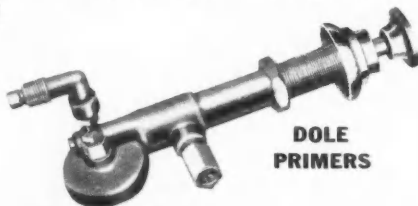
As an established supplier under the old order we still consider the automotive industry a natural market. Whenever priority conditions or schedules permit, we shall find ourselves doing business with many an old customer.



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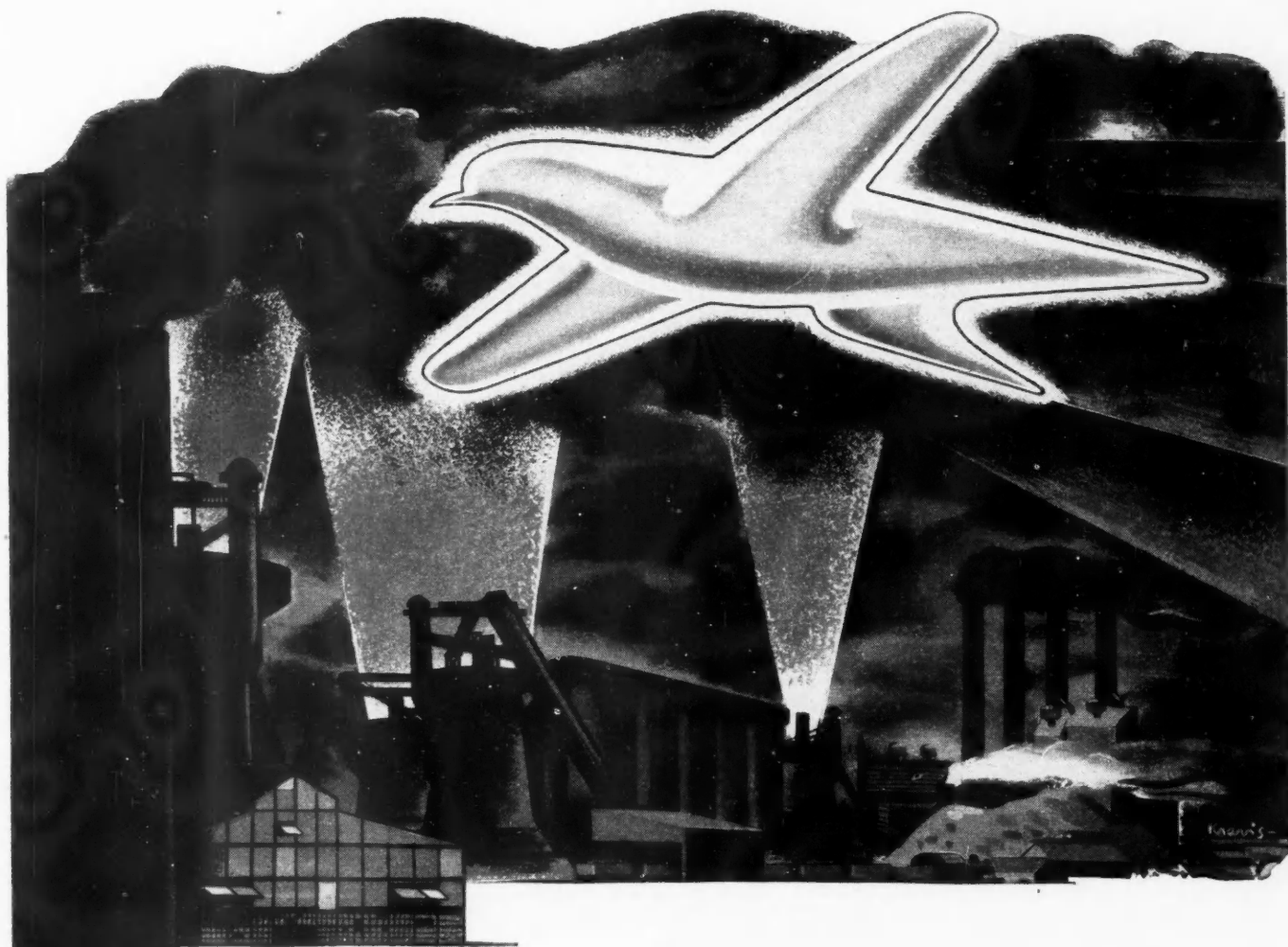


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Magnesium is one of the lightest metals known. One pound will do the work of one and one half pounds of aluminum and five pounds of copper, and magnesium alloys have been developed with an ultimate strength of more than 60,000 pounds per square inch.

Before the war there was only one magnesium and one aluminum producer in the United States . . . after the war there will be as many as ten magnesium producers and four aluminum producers! What's more, these metals are among the most abundant of all, and full production should reduce the prices of both to levels never dreamed of before.

Likewise in steel, in just two war years our

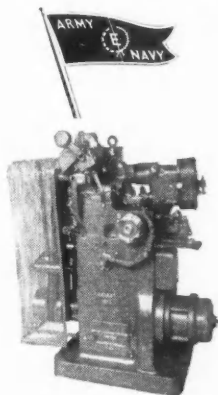
capacity for electric-furnace steel has increased an incredible 85%, and new lightweight superstrength alloys have been developed which can now be welded, with great savings in costs and time.

What does all this mean to the post-war world just ahead? It means that aircraft, automobiles, trucks and trains will be lighter, stronger and cheaper. It means that rivetless ships will slide off the ways, and rivetless planes will roll off the lines. It means greater speed and lightness and strength and economy.

And it means *problems!* Problems in production, in fabrication, in tooling and in design. Problems in the new light metals of the new Light Metal Age!

Bryant engineers are among the foremost authorities in America on problems involving machine tool operations with the new light metals. Send us your problems now!

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BRYANT CHUCKING GRINDER CO.

SPRINGFIELD, VERMONT, U. S. A.

Air Corps, Dayton, Ohio, the paper being based on a thesis submitted by the author in partial fulfillment of the requirements for the Master-of-Science degree at the University of California. The type of suspension dealt with is that commonly used in mounting engines in automobile chassis. Seven different rubber compounds were experimented with, the compositions, cure and durometer hardnesses of which were given in the paper. The tests were carried out on specimens of the type represented by the drawing, the rubber being subjected to shear by means of a motor-driven eccentric with a connecting rod, which imparted a substan-

tially simple harmonic motion to part B, of an amplitude of approximately 0.0015 in. and a frequency varying from zero to 50 cycles per second. There was a dead-weight load on part A which could be varied from 10 to 100 lb. Motions of both A and B were restricted to practically vertical displacements by radius rods 4 ft. long. Two modified Geiger torsionographs, one connected to each member of the mounting, were so arranged that the vibrations of A and B were recorded simultaneously on a paper tape. Thus both the frequency and the amplitude of vibration at any instant could be determined. With B stationary it was possible to displace

and suddenly release A, and the free vibration of this part was then recorded. In this manner the natural frequency of the loaded mounting was determined.

For any given frequency the ratio of the amplitude of vibration of A to that of B is a direct measure of the transmissibility of the mounting. The transmissibility is greatest if the exciting force has the same frequency as the natural frequency of the mounting. With a properly-designed mounting the impressed periodic force generally has a frequency of from three to ten times the natural frequency of the mounting.

In the course of the investigation a criterion for the effectiveness of shear-stressed rubber compounds in isolating machinery vibrations was developed. In the past it has been common practice to regard either the hardness or the shear modulus of elasticity as the important characteristic, but it is the



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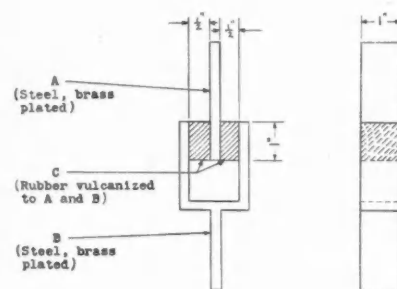
FORMED in one step from a straight tube . . . NIBCO WROT tees, crosses, ells, and return bends are marvels of engineering development. Every one is perfectly formed . . . absolutely "round and square" . . . uniform in thickness and strength. The same engineering genius which made this possible is at work today developing new products and time-saving processes for war. NIBCO valves and fittings will have their share in winning it. But in the new day that is to come . . . you'll need us and we'll need you. Remember NIBCO service . . . from blueprint to packaged product . . . made right . . . delivered on time.



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VALVES AND FITTINGS SINCE 1904



Details of typical rubber machinery mounting used experimentally.

contention of the author that this does not suffice for rational design. The "criterion of effectiveness" developed by him is as follows

$$\beta = \frac{\gamma \epsilon_{max} G}{S}$$

where γ is the ratio of the dynamic to the static stiffness of the resilient mounting

ϵ_{max} the maximum value of the transmissibility;

G , the applied load per unit of shear-stressed area necessary to produce unit deflection of the mounting per unit of thickness of the rubber stressed, and

S , the breaking strength per unit of shear-stressed area of the rubber compound.

However, the criterion β is an inverse one, for the smaller its value the better the compound is suited for use in shear-type flexible mountings. The values of β for the seven rubber compounds tested ranged from 2.51 to 17.2 (average values for different degrees of loading). The lowest, optimum value applies to a compound consisting of 100 parts smoked sheet (rubber), one part stearic acid, one part neozone A, one part Captax, one-half part zinc oxide, one-tenth part diphenyl guanidine, and two parts sulfur. This compound, which was



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cured for 40 min. at 307 F, had a durometer A hardness of 30—considerably lower than that of any of the other six compounds.

Edge Reinforcements for Cut-Outs in Monocoques.

IN modern aircraft, and especially in military types, the uniform structure of a monocoque fuselage and that of a wing is interrupted in many places by cut-outs for doors, windows, retracting landing gears, gun turrets, bomb emplacements, etc. Determination of the stresses in the neighborhood of such cut-outs is one of the difficult prob-

lems the aircraft stress analyst has to face. N. J. Hoif, of Brooklyn Polytechnic Institute, in a paper presented at one of the aviation sessions made an attempt to solve part of the problem by developing a mathematical procedure for the calculation of the moments acting upon the space-curved bar secured to the edge of an opening in order to reinforce it. The procedure was developed in connection with the preparation of a thesis submitted to Stanford University for the Ph. D. degree.

It is of obvious advantage to have the strength and stiffness of the structure unimpaired by the cut-outs. If the weight is not prohibitive, it is de-

sirable, therefore, to provide edge-reinforcements stiff enough to prevent any greater distortions than would occur in the monocoque structure without openings. With such stiff reinforcements, the stresses in the neighborhood of any cut-out are not affected by its presence, and, consequently, the forces transmitted from the monocoque structure to the edge-reinforcement are the forces that would act in the undisturbed structure at the location of the edge-reinforcement. In most cases these forces can be easily calculated.

An actual edge-reinforcement usually deflects more than the ideal one, and therefore, carries only part of the load that would be transmitted through the structure if no cut-out were provided. Thus, if the edge-reinforcement is designed on the assumption of loads corresponding to the ideal case, the error committed is on the safe side from the viewpoint of the necessary strength of the edge-reinforcement.

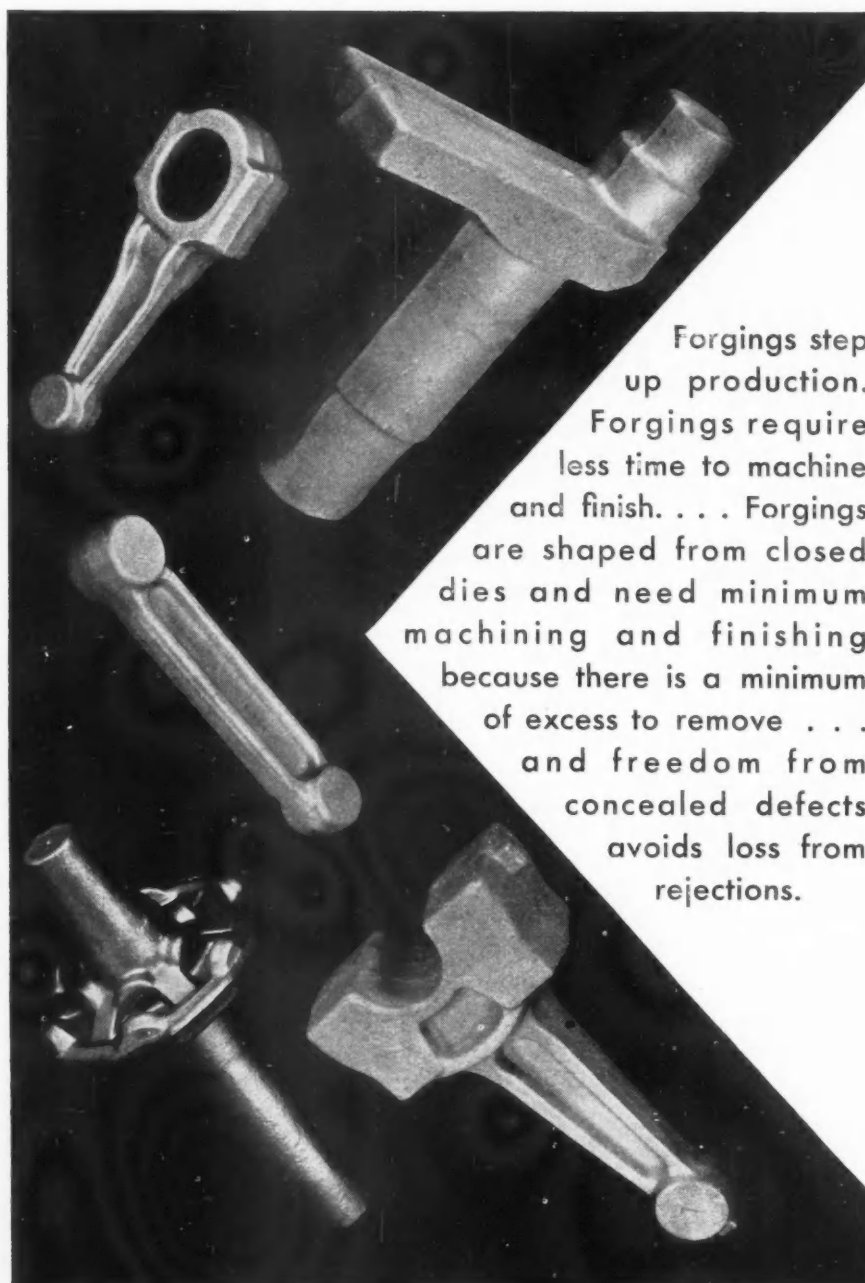
In the paper the loads were assumed to correspond to the ideal case, and the procedure was presented as applied to the example of a cut-out in a fuselage loaded in pure bending, the cut-out being symmetrical with respect to both the plane of symmetry of the fuselage and to a plane perpendicular to its generatrices. As the procedure is mathematical in nature, it cannot be given in abbreviated form.

Measuring Exhaust Temperatures

W. J. KING of the supercharger engineering department of General Electric Company presented a paper dealing with the factors affecting readings of thermocouples in gas streams at temperatures of 1200 F to 2000 F. He said that with unshielded thermocouples mounted in bare pipes carrying gases at 1800 F, errors as high as 200 deg. are caused by the intense radiation from the couple to the pipe wall. Mr. King described several types of shielded thermocouple mountings developed to reduce this error to the practical minimum for reasonable size and weight. Tests with one of these, a small quadruple-shielded type, showed that the error will not exceed 20 deg. at 1800 F or 10 deg. at 1200 F with air or exhaust gases at velocities of 100 to 400 fps in a bare pipe. The wires of this thermocouple are No. 18 Chromel-Alumel, insulated by porcelain tubing protected by a metal sheath. A high-temperature alloy known as KA2SMO (18-8 stainless stabilized with molybdenum) has been found very satisfactory for the metal parts. Mr. King said this type had been found satisfactory for both ground and flight testing.

Dr. Dryden Heads I.A.S.

Dr. Hugh L. Dryden, of the National Bureau of Standards, Washington, D. C., has been elected president of the Institute of the Aeronautical Sciences for 1943, it has been announced by the institute.

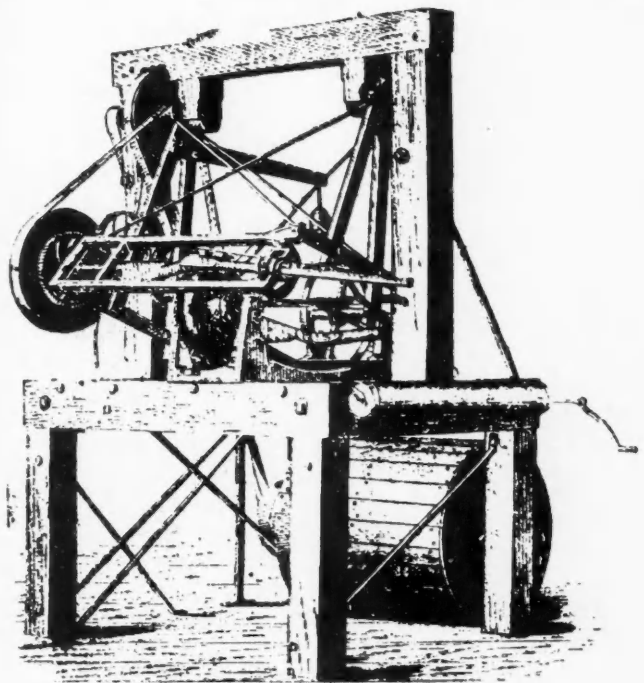


Forgings step up production. Forgings require less time to machine and finish. . . . Forgings are shaped from closed dies and need minimum machining and finishing because there is a minimum of excess to remove . . . and freedom from concealed defects avoids loss from rejections.

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A Curious Machine

*has lately been
advertised that
will churn, scrape
Potatoes, rock
the cradle and
Darn Stockings.*



THIS bit of early-American humor, which appeared in a New England newspaper more than a century ago, may well have been inspired by the "curious machine" shown here. It marks the beginning of a public awareness of the mechanical wonders ahead . . . Back in the days when "Industry" was spelled with an *i*, it was the birth notice of the Machine Age in America.

Picture the times when that notice appeared: Witchcraft was still a subject for serious dispute, and sane men believed that insanity was caused by Devils. Cocked hats and big-buckled shoes were still to be seen, and sober men declared the steam engine a passing idea, over their tankards of flip in the taverns. . . . The hammer and anvil were the symbol of the times, and every part of every musket or cannon or clock was made individually, by hand.

That was the setting. And in the midst of it, some of the greatest inventive geniuses the world has ever known were quietly changing the shape of things and of thought with the "curious machines" they were inventing. Such

curious machines as the one shown here. Machine tools, with which each part could be made in quantity, and precisely alike. . . . Tools that were to make machines that would churn, scrape potatoes, rock the cradles of industry, and even darn stockings!

★ ★ ★ ★

BUT they were doing more of importance than inventing curious machines. Those men of mechanical genius were founding a handful of machine tool companies that have literally made possible all the rest of industry.

One of those companies — Jones & Lamson — is here today, a direct descendant of the first great machine tool builders in America. With a heritage of skills, knowledge and equipment that has constantly grown, from the very birth of our industrial age, Jones & Lamson engineers and service men are particularly qualified to serve any phase of industry today and during the difficult period of post-war readjustment ahead.

Jones & Lamson service is at *your* service now!



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SPRINGFIELD, VERMONT, U. S. A.

Manufacturers of Rom & Saddle Type Universal Turret Lathes . . . Fay Automatic Lathes . . . Automatic Thread Grinding Machines . . . Comparators . . . Automatic Opening Threading Dies and Chasers.

**Profit Producing Machine
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all offensive weapons have become vitally important in war strategy. Length, accuracy and striking power supersedes size in many tasks. Like the hard-hitting dive bomber and other mighty midgets of HOLTITE Screws, Bolts and allied fastenings perform tasks far out of proportion to their size. Scientifically produced with the uniform precision of small tools these rugged fastenings

are used in the assembly of practically all weapons of war to provide time-saving application and faultless, enduring service.

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Manufacturers of
**Enduring, Fine Precision
SCREWS · BOLTS · NUTS**
and Allied Fastenings

Conservation of Critical Materials

(Continued from page 29)

The new Timken process results from the adoption of the National Maxi-Pres forging machine, in combination with a new approach to die design, and a unique sequence of forging, trimming, and normalizing procedures.

When differential pinions were produced by conventional methods, they started with bar stock weighing 4.77 and 1.65 lb, rough, and were trimmed down to 1.34 and 0.50 lb respectively, leaving a chip loss of 3.43 and 1.15 lb, respectively. With the new method, the blanks start with billets weighing 2.12 and 0.92 lb, respectively, and in their finished form weigh slightly more than the cut pinions due to the denser and more perfect structure produced by forging.

Timken claims that the new process will save around a million pounds of steel in a year's time, and will save thousands of hours of machine time.

Another element contributing to "more-faster-from-less" is the suggestion system which has been placed in effect in many plants. General Electric Co., reports on several imposing cases developed in recent months.

G.E. has paid out in 1942 about \$100,900 for 11,000 suggestions that were adopted. Among the most recent is the suggestion of a set-up man who conceived the idea of a universal work-holding fixture for precision grinding operations on naval ordnance parts which are held to a tolerance of 0.0002 in. Formerly these parts were held in separate fixtures. Now they will use a universal fixture which eliminates about 5000 man-hours per year in set-up, and reduces rejections to a new low of 2 per cent.

A layout man in GE's welded products department suggested a re-arrangement of ship motor parts cut from large steel plates, producing an increase of 25 per cent in parts cut from each plate. This procedure will save 110,000 lb of steel, supplementing an earlier suggestion by the same man that resulted in a saving of 500,000 lb of steel.

A punch press operator at GE recommended the use of a slightly smaller silicon steel sheet used for lamination punchings, producing a saving of 15,400 lb of steel on one order alone.

The foregoing is but a sampling of the fruits of the nation-wide drive to produce more from less. These examples indicate how the combination of know-how in design, metallurgy, and production techniques can enable this country to accelerate the output of war goods without ever reaching the limits of our capacity to produce raw materials and without experiencing a critical shortage in man power.

Given wide circulation in American industry, these basic ideas will make people think—will start the ball rolling in other quarters.

AUTOMOTIVE and AVIATION INDUSTRIES



MAKING SAPS OF THE JAPS

Despite the vaunted ability of the Japs to imitate almost anything we have done, *they cannot keep up with what we are doing.* They cannot match America in specialized mass production.

The superior planes and more of them with which we will overwhelm the enemy calls for drop forged parts in quantities never before contemplated.

Kropp has answered this call by building

a large new plant, devoted exclusively to the high production of forged aircraft parts. In this plant are found production facilities that no enemy can match for turning out, in any quantity, forged parts for aircraft engines, wings, struts, fuselage, bomb racks and other forgings required by the aviation industry.

We solicit the inquiries of plane and engine builders for forgings of all types.

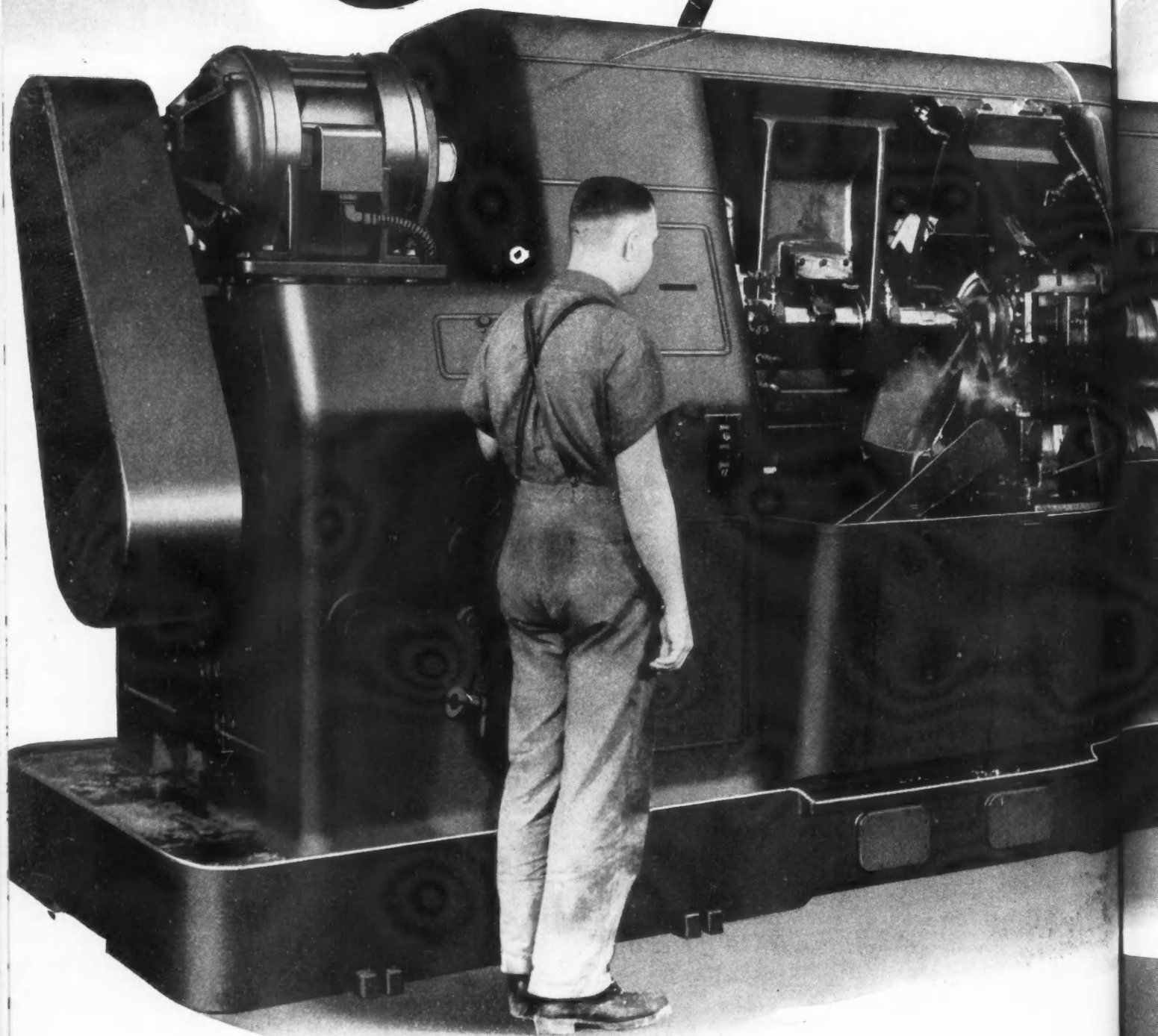
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SPINDLE
CAPACITY

Acme-Gridley



LENGTH 14'6" • WIDTH 5'7" • HEIGHT 8' • WEIGHT 70,000 Lbs.

HEIGHT TO CENTER TOOLING ZONE - - 4'6"

LARGEST MULTIPLE SPINDLE AUTOMATIC INCREASES OUTPUT *Ten Times!*

A WAR ASSIGNMENT—AGAINST TIME



With total war came the jump — demand from hundreds to thousands of airplane motors and tanks per month. These require precision parts of large diameter and on schedules that single spindle methods could not possibly meet.

Our Government said "Build 8 inch Acme-Gridley 4 Spindle Automatics for these parts manufacturers; apply your experience, skill, plant facilities — and lose no time."

In less than 5 months we designed, built, tooled and delivered the first machine to customer's plant. Immediately and without makeshift it was pronounced "running to perfection" and **PRODUCING THE JOB 10 TIMES FASTER THAN HAD BEEN POSSIBLE BY THE FASTEST SINGLE SPINDLE METHOD PREVIOUSLY USED.**

The record time from design to delivery included our building jigs, fixtures for complete interchangeability of tooling and parts. And continued deliveries of many more of these 35 ton giant multiples have not interrupted our production of the hundreds of six spindle Acme-Gridley munition automatics in other sizes on war schedules.

We are proud to have fulfilled this, our special war assignment, on time and in time.

THE NATIONAL ACME

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ACME-GRIDLEY 4-6 AND 8 SPINDLE BAR AND CHUCKING AUTOMATICS • SINGLE SPINDLE AUTOMATICS • AUTOMATIC THREADING DIES AND TAPS • SCREW MACHINE PRODUCTS • THE CHRONOLOG • LIMIT SWITCHES • SOLENOIDS • POSITIVE CENTRIFUGE • CONTRACT MANUFACTURING

Air Cargo Stimulated by War

(Continued from page 37)

men. Such a terminal must be convenient to the runway layout, to loading docks, highways with ample equipment for weighing and inspection. There must be room for dead storage, provision for handling perishable goods, cold storage facilities, ways and means for crating and packing. Loading and unloading devices, etc.

In addition there must be illumination for night handling to say nothing of protection against ice, snow, freezing temperatures, hot sun, vaults for valu-

able cargos, and so on. Furthermore the air cargo terminal of the future will be air conditioned. There will be garages, for the mobile equipment. The place will have its heating system, a locker room, crew lounge, pneumatic tube system for control and in all other respects be self sustaining and apart from passenger handling.

Three papers were given in the technical session at which the Hon. William A. Burden Special Assistant on Aviation to Secretary of Commerce, acted

as chairman. In his paper "Packaging and Handling Of Air Cargo," C. G. Peterson, chief engineer, Railway Express Agency, Inc., brought out many of the same thoughts on the preparation and handling of cargo as those voiced by Mr. Larson in the morning's session.

"Some Aspects Of Air Cargo Operation In Latin America" was the title of the paper by J. Parker Van Zandt, Director Office of Air Transport Information, U. S. Department of Commerce. A pioneer in blind flying and holder of No. 17 Pilot's License, the author revealed that the airline network in Latin America is two and a half times greater than in the United States and that nearly six and one-half times as much cargo is flown there as here. This leadership, he attributed to the foreign nations desirous of building an air empire in the West only to lose to America through the "good neighbor policy" and the war. Mr. Van Zandt pointed out that 60 per cent of one company's revenue in 1940 came from freight as compared with but 3 per cent from that source by our domestic air carriers.

A benefit of air transport, not generally known, said the speaker, is the lower insurance premium because of the freedom from theft while in transit over interior surface routes. Summing up, Mr. Van Zandt said:

"There undoubtedly is a large amount of commodity traffic available to be carried by air between North and South America but it should be figured in millions of pounds rather than in millions of tons. The war has developed long-haul air cargo operations, but it still remains to be determined what proportion of these shipments will continue to travel by air after the emergency."

J. V. Sheehan, Manager Industrial Division, Lockheed Aircraft Corp., talked of "The Economics Of Post War Carriage Of Air Cargo." He said that the Army Air Forces have become the proving ground for many phases of tomorrow's commercial air-cargo services. In considering the part the airplane will play in domestic and world commerce tomorrow, the present attitude toward the cost item will be reversed and will then be of paramount importance, he said.

A comparison of costs and operating conditions leads to the assumption, said Mr. Sheehan, that the part of wisdom for air carriers is to concern themselves with the planning of equipment on which the cost of operations would enable them to compete for the higher classes of surface freight, express and mail markets.

The Wednesday morning session, presided over by Peter Altman, Vultee Aircraft, opened with the paper by Col. Edward S. Evans, President Evans Products Co., and entitled "Securing Means For Air Cargo." Having developed such items as the Evans Auto-loader, auto-trailer, freight-car utility loader, cargo fasteners for planes and numerous other aircraft parts and ap-

ACP PRODUCTS and PROCESSES

- for greater output
 - better painting
 - savings in critical materials
- in the production of

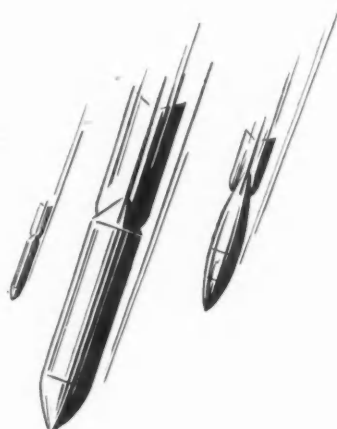
SHELLS and BOMBS

DEOXIDINE's ability to eradicate rust chemically has been long recognized. In the munitions industry today, as in the sheet metal industry in the past, it eliminates laborious hand operations for rust removal, speeds production, and leaves metal surfaces prepared properly to receive paint.

Pickling provides a quick, easy and economical method of re-

moving scale, and this operation is made safe and efficient by the addition of RODINE, the acid inhibitor, to the pickling bath.

The ACP Alkali Cleaning System utilizes RIDOLINE in spray or dip method to speed production . . . followed by diluted DEOXYLYTE to counteract alkalinity. Critical materials are conserved for more important uses by substituting this ACP Process.



All along the industrial battlefield ACP Products and Processes are helping. LITHOFORM coats galvanized iron to hold paint; FLOSOL is an exceptional soldering flux for many metals; KEMICK holds to and protects metal surfaces even when heated red-hot; CUPRODINE to provide dense, bright copper coating on steel by simple immersion.

Whatever your metal treating or finished problem, call on ACP. Make use of the 25 years of pioneering and experience in these operations.

AMERICAN CHEMICAL PAINT CO.
MAIN OFFICE AND WORKS
AMBLER, PENNA.

ACP
CHEMICALS
ACP
PROCESSES

DETROIT, MICH., 6335 Palmer Ave., E.
CANADIAN BRANCH
WALKERVILLE, ONT.

To prove parts right or wrong . . . quickly

the Electrolimit Gage



HE IS using a master disk to set his gage . . . a matter of only a minute or two . . . and he'll be ready to check parts precisely to "tenths." Pieces will flow through inspection *rapidly*, with a minimum of eyestrain or fatigue . . . with *no* "operator variation," *no* element of human error. Frequently women do it better than men.

For this is a P&W Electrolimit Gage — one of many Pratt & Whitney products that provide *basic accuracy* for mass production. By mechanical-electrical magnification, this type of P&W gage may enlarge an error as much as 20,000 times. In various forms, it checks internally or externally, one dimension or several simultaneously. In one of its forms, it grades parts in increments of .0005" for selective assembly. It is unusually versatile . . . will serve its owner well in war or peace.

If you need basic accuracy for mass production, call on Pratt & Whitney. There is no better paying investment than the right tools for each job. Details of P&W Electrolimit Gages will be supplied on request.



PRATT & WHITNEY
Division Niles-Bement-Pond Company
WEST HARTFORD • CONNECTICUT

pliances, the speaker was well qualified to present his subject. Said he:

"Air cargo will provide a splendid supplement to railway freight transportation and will be the means of drawing continents much closer together than ever before. While I have been a firm believer in the possibilities of air freight for more than a decade, it required a war to bring about this great new phase of freight transportation to a head."

"Structural Materials For The Cargo Plane" by H. D. Hoekstra, assistant chief, Aircraft Engineering Division, Civil Aeronautics Authority and "Airplane Design For Cargo Transporta-

tion" by Carlos Wood, Proposals Engineer, Douglas Aircraft Corp., dealt largely with the physical requirements, structures and materials for future plane designs.

The cargo glider session for which C. Graddick of United Air Lines acted as chairman produced an unusual amount of interest. Evidently the rosy dreams of many in which "trains" made up towing planes, each pulling several gliders through the air, the gliders to be successively cut off are certain designated spots in the country without stopping the tow plane, may yet be realized. In the absence of Mr. Richard DuPont, President, All American Avia-

tion, Inc., his paper "Air Pickup and Gliders As Related To The Future Of Air Cargo" was presented by Mr. Stringer of the same company.

"Glders For Transport" was the paper given by Maj. L. D. Barringer, Chief, Glider Unit, Directorate of Air Support Army Air Forces. Major Barringer brought out the interesting fact that glider operation with a plane has over a period of experimentation shown a 46 per cent increase in load carrying capacity over the plane alone. This is true even in unmatched wing loading between that of the towing plane and glider.

Much stress was placed on the importance of matched wing loading between tow-plane and glider. If both are matched or nearly so, little or no difficulty will be experienced, said, Major Barringer, so far as take-off and flight is concerned. This, however, is true when the pilot of the plane and of the glider are experienced in this sort of air activity. It is essential, he said, that one or the other pilot of such a combination must have had experience to cope properly with such things as slack in the towing line, which can produce all sorts of strange antics in the sky, especially with unfavorable wind conditions.

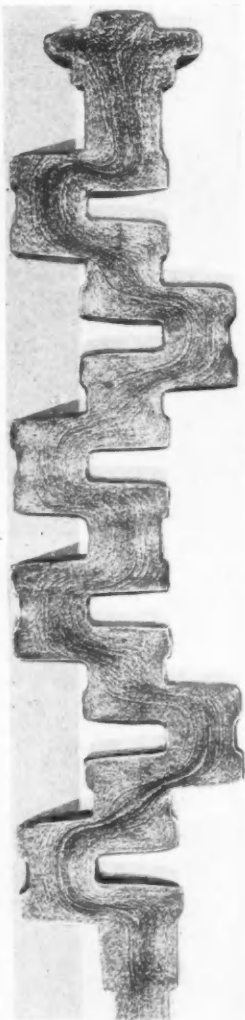
Results of many tests show that the engines of the towing planes are not abused by glider operation and furthermore, that there is not even a noticeable slowing down of the prime mover. The take-off of a glider when towed can be perfectly normal and ideal conditions are approached both on take-off and flying if the wing loading of the glider has been matched to that of the towing ship.

Flight without power can and has resulted in 100 per cent more load carrying ability and a 10 to 15 per cent decrease in cost over that of the airplane alone. Army gliders, said, Major Barringer, are designed at present with one main objective in view—landing troops safely at predetermined fields or wherever the occasion demands. The rapid development in glider operation, said he, is a war measure to find out if more and how much more can be carried by the use of gliders.

The program of banquet speakers included Commander C. H. Schildhauer, Reserve Naval Air Transportation Service, Navy Dept. and Col. Harold R. Harris, Asst. Chief of Staff, Plans Div., Air Transport Command, Army Air Forces.

Commander Schildhauer told of what is being accomplished these days in naval air transport. He particularly lauded the untiring efforts of domestic air line companies in turning over much of their operating experience to the Navy and along with it personnel thoroughly skilled through peace time transport service.

Col. Harris told the group that the Army world air routes now total something like 60,000 miles as compared with a pre-war total of about 41,000 miles for all domestic air lines in the



End-to-end section of Atlas crankshaft showing perfectly controlled grain flow.

FORGING CLINIC

Here is a study in vivisection of a live drop forging. This experiment may be likened to physiological studies that have in the past determined muscular formations, circulatory and nerve systems which, once ascertained, can always be depended upon as fact.

Atlas Drop Forging success depends upon like facts found by laboratory procedure at every step of manufacture. The steel maker's billets, bars and rods are first checked for correct formation. From that point on, through processes of pre-heating, forming, twisting, upsetting, heat treating, we are concerned with maintaining the grain flow as shown in the photographic reproduction at left.

Nothing is repoured. Herein lies the reason why Drop Forgings possess the highest safety factors, the surest protection against failure in actual use.

ATLAS DROP FORGE COMPANY
Lansing, Michigan

Complete
Laboratory
Control

ATLAS
DROP FORGINGS

BEARINGS THAT FLY

Must Have *"What It Takes"*



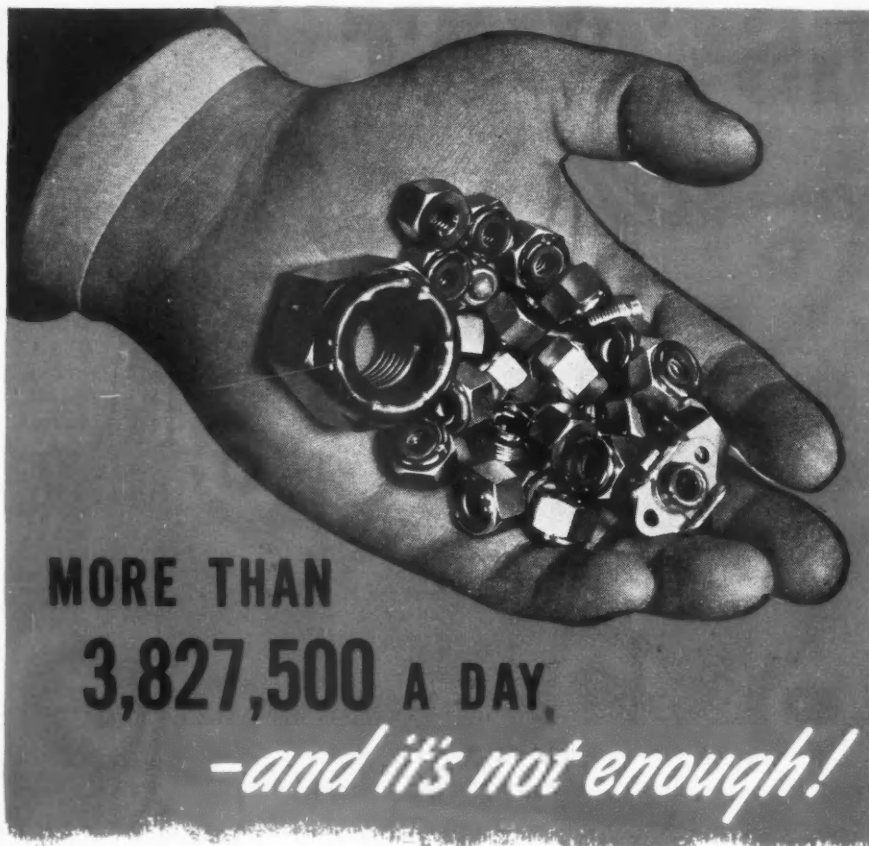
This remarkable new testing device is built on tracks that permit aircraft engines to be operated in positions of actual flight.

No other application in mechanical history has ever demanded so much from bearings of the size and weight of those supplied by Bunting for modern aircraft engines. New and unprecedented limits are imposed on all operations in the manufacture of these bearings. If unusual requirements today involve a bearing problem, Bunting experience and resources can aid you. The Bunting Brass & Bronze Company, Toledo, Ohio. Warehouses in All Principal Cities.



Bunting

BRONZE BUSHINGS • BEARINGS • PRECISION BRONZE BARS



EVERY single day almost four million Elastic Stop Nuts go into war production.

Even at that, and with all our expanded plant, it doesn't fill the demand.

It happens that the most urgent need right now is on aircraft. Every American plane that takes the air has some important part of its structure fastened with these strong, tight-holding nuts. Some types take as many as 35,000 in a single ship.

The reason is: *these nuts stay put under the toughest circumstances.*

You handle them exactly like regular nuts. They go on fast, lock im-

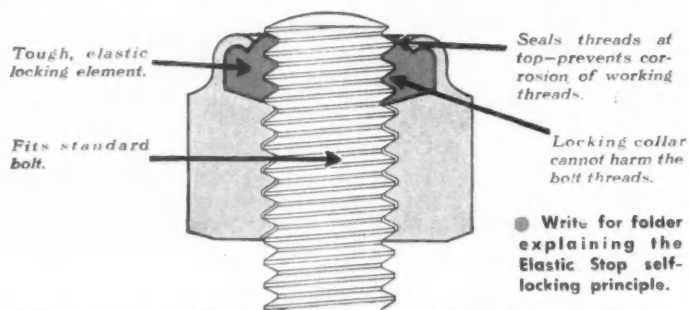
mediately and automatically.

There's no need of pins, washers or auxiliary locking devices.

Once on, they stay there—never shake loose. But you can take them off and put them back on many times and they won't lose their locking ability.

This is why there are more Elastic Stop Nuts on America's planes than all other lock nuts combined. And why they are also used in important structural applications on guns, naval vessels and other war equipment.

We have made billions of Elastic Stop Nuts and, as far as we know, not one has ever loosened.



ELASTIC STOP SELF-LOCKING NUTS AND AIRCRAFT FITTINGS

ELASTIC STOP NUT CORPORATION

2330 Vauxhall Rd., Union, N. J.

 WITH THE RED COLLAR—SYMBOL OF SECURITY

United States. Furthermore, he said that in one recent month the air transport command's ton-mileage was larger than the combined totals of all the air lines in the United States during 1941.

William B. Stout acted as toastmaster at the banquet. In the absence of Col. A. W. Herrington who was scheduled to talk on the SAE War Effort Activities, Mac Short, incoming president of the SAE made the address. He lauded the work done by the Chicago section in making the Air-Cargo meeting possible. The efforts of the Chicago section produced record crowds attending the technical sessions as well as the dinner.

New Tool Revolutionizes Long Hole Boring at North American Plant

(Continued from page 42)

The bar, simply constructed and simple to use, has revolutionized the process of long hole boring at North American. The success of its operation is dependent upon the support that the Neoprene ring assembly furnishes to the cutting tools themselves. The Neoprene ring assembly is held rigidly in a guide sleeve that is mounted in an adjustable bracket directly ahead of the cylinder to be bored.

All of the rings are in contact with this sleeve during the time that the tools are starting their cut, which results in rigid support and an accurate start. As the tools are fed on and proceed through the cylinder, the rings follow out of the guide sleeve and into the cylinder, lending their rigid support directly behind the tools, and in the finished bore itself, throughout the entire length of the bore. This rigidity also is extremely essential for the efficient operation and use of carbide tipped tools, due to the fact that any carbide tool tends to chip and fracture unless it is rigidly supported both in the body of the tool itself and in the housing and support that holds the tool in its operation.

Practically all chatter is eliminated, which thus measurably increases the life of the tool. The tool, which makes possible the elimination of the grinding operation, will bore consistently with very minute taper throughout; this, in conjunction with the lack of chatter marks, has decreased the amount of stock left for honing to a point where it is now necessary to leave merely .006 to .008 in. stock on the diameter for honing. Heretofore, it was necessary to leave as high as .020 in. on the inside diameter for this purpose. The tool is also useful in trueing up holes which have been previously bored irregular. Although it is not practical for long runs, operators have finish-honed a few cylinders that had but .002 in. and .003 in. of stock for honing and they cleaned up extremely well.

CHECK THESE ADVANTAGES OF BLANCHARD GRINDING

★ **Production**

★ **Adaptability**

Fixture Saving

Operation Saving

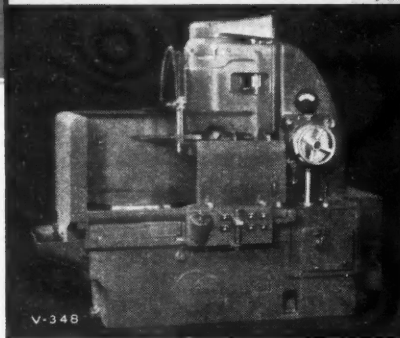
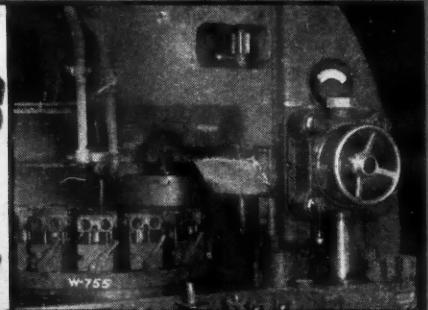
Material Saving

★ **Fine Finish**

★ **Flatness**

★ **Close Limits**

"PUT IT ON THE BLANCHARD"



Oil burner pump parts ground on the Blanchard No. 18 Surface Grinder.

THE BLANCHARD NO. 18 SURFACE GRINDER is used to rough and finish grind the oil burner pump parts shown above. They are first ground from the rough, then they are normalized and ground again. All boring and drilling operations are located from the flat Blanchard ground surfaces. After machining, all parts are finish ground on the Blanchard. Twelve pump bodies are ground at once on fixtures mounted on one base plate. The base plate is held magnetically, therefore the chuck may be cleared quickly for a change of jobs. The cast iron pump bodies are 6 inches in diameter. .012" of stock is ground off one side to limits of $+.0003''$ $-.0001''$ at a rate of 48 pieces per hour.

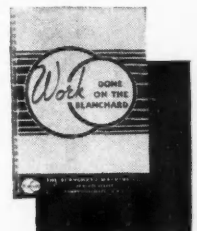


..... Especially
valuable on jobs like
the one illustrated.

The **BLANCHARD**
MACHINE COMPANY
64 STATE STREET, CAMBRIDGE, MASS.



Send for your free copy of "Work Done on the Blanchard." This book shows over 100 actual jobs where the Blanchard Principle is earning profits for Blanchard owners.



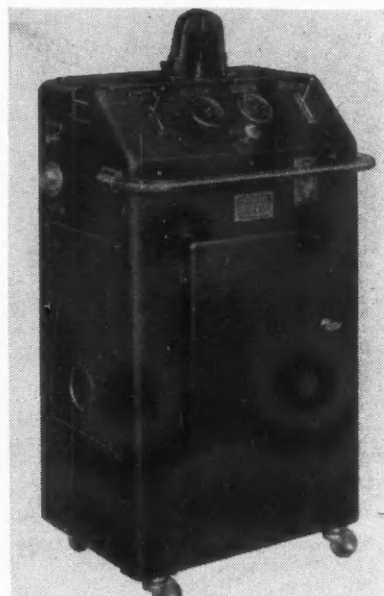
New Products for Aircraft

(Continued from page 41)

hydraulic system through a hydraulic accumulator. The weight of a double unit, consisting of two valves in a single housing with levers and return springs, is 3¼ lb. Where standard dimensions do not have to be maintained, size and weight can be reduced. With proper choice of pedal operating lever and lever attachment, this type valve will operate brakes whose maximum working pressure ranges from 175 psi to 750 psi.

Hydraulic Spark Plug Tester

Designed for use as Air Corps ground equipment, a hydraulic spark plug testing unit is being manufactured by The Denison Engineering Company, Columbus, Ohio. The tester develops air pressure up to 750 psi within 15 sec and maintains that pressure for a full minute. The testing time averages about 30 sec per spark plug. To test, a plug is seated in the adapter, and the action

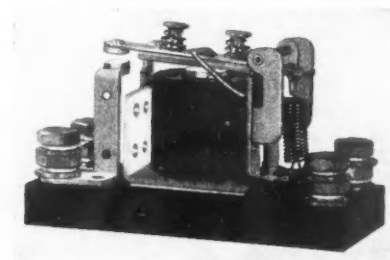


HydrOillic Spark Plug Tester Made by the Denison Engineering Company.

of the hydraulic cylinder clamps the plug into an air-tight chamber. The desired voltage and pressure are selected and the action of the plug recorded. As a safety feature, the operator is forced to move two levers, one with each hand, in opening or closing the mechanism. This makes it impossible for him to have his hands in or about the clamping mechanism when it is in operation. The electrical circuit to the spark plug is completed only after the plug is clamped into position, and the circuit is automatically broken when the clamp is released, making it possible for the operator to handle the plug in complete safety. The stand consists of a welded steel frame mounted on swivel casters and equipped with start-stop push buttons, high and low pressure gages, low pressure needle valve, adapters, oil level gage, high voltage connector, low voltage terminal and operating levers.

Relay for Aircraft

The B-2-A relay is one of a series in the new line of units which have been designed for remote control of aircraft electrical circuits by Guardian Electric, Chicago, Ill. Built to Army Air Force



The B-2-A Relay made by Guardian Electric.

KNOW THESE POINTS OF LITTELFUSE PROTECTION
FOR BETTER FUSE SERVICE

6 TIMES
THE SERVICE LIFE
OF ORDINARY
CONSTRUCTION



PROVED BY THE

LITTELFUSE

✓ Non-Crystallizing Fuse Element

The Littelfuse "Gooseneck" spring-forming at end of fuse element takes up contraction and expansion, a common cause of fuse failure due to crystallization and cracking of the element at fusion point. Littelfuses are dependable!

AIRCRAFT ANTI-VIBRATION TYPE LITTELFUSES



**Littelfuse
5 AG**
Aircraft Anti-Vibration type.

Exclusive Littelfuse Design

- (1) Locked cap assembly.
- (2) Element twisted at 90° braces against vibration.
- ✓ (3) "Gooseneck" non-crystallizing fuse element takes up contraction and expansion. Solves heat problem.

SEND FOR COMPLETE LITTELFUSE CATALOG

For illustration and explanation of these and other Littelfuse features. Also pictures and describes Littelfuses for all aircraft, auto, radio, ordnance, marine services—every instrument purpose. Clips, Panels, Mountings, Extractor Posts, etc.



LITTELFUSE INC.

4731 Ravenswood Ave.

Chicago, Ill.



This year, an Eagle flies

NEW HOPE and the spirit of Victory are strongly with us now as the spreading wings of the American Eagle bring us the infant New Year.

United to win, America greets the New Year—each and every one of us eager and ready for every needed war effort . . . cheerfully ready for any needed sacrifice. With this spirit, the New Year will take us far on our way to the ultimate victory and happier years that lie just ahead.

The Ross organization goes into the New Year with high hope, confidence and determination to do everything within our power to speed production and thus hasten the day when we return to the certainties and securities of a new and enduring peace.

Ross

Cam & Lever STEERING

JOINS THE PRODUCTS of countless other American industries, in helping win the war. Ross Cam and Lever Steering is being used in jeeps, prime-movers, all manner of vehicles, large and small, by our armed forces. We can serve no one else until this war is won. Then, on that good day, we'll again be providing steering, at its best, for the vehicles of peace.

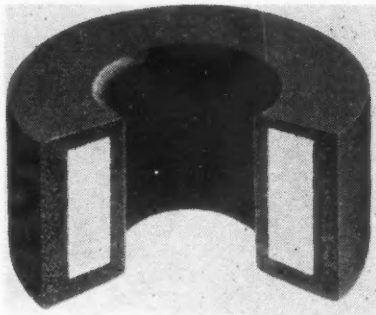


ROSS GEAR AND TOOL COMPANY • LAFAYETTE, INDIANA

specifications, the unit has contact rating of 25 amperes continuous and 100 amperes surge at 24 v d.c. It has single pole, single throw, normally open contacts and weighs 6 oz. The manufacturer claims that the unit has acceleration and vibration resistance of more than 10 times gravity. Metal parts are plated to withstand 200-hr salt spray test.

Rubber Moldings with Felt Cores

Co-operative research and experiment on the part of two well-known British firms—the Empire Rubber Co. and the Bury Felt Manufacturing Co.—have re-



Moldings comprising a core of felt and a "corral" of rubber.

sulted in the development of what is claimed to be a new rubber-molding technique, by means of which moldings consisting of a core of felt surrounded by a "corral" of rubber are produced. The saving in rubber in some cases amounts to as much as 75 per cent; besides, the moldings are from 30 to 75 per cent lighter than corresponding all-rubber moldings. It is also claimed for "Relt" (the name given to the new product) that variations in the degree of resilience are more easily obtained and controlled than with all-rubber moldings, for a felt core of any degree of hardness can be used, as required.



... AND LONGER LASTING AETNA BALL BEARINGS

★ Remember the wiser you buy the more you help to conserve labor and materials that are indispensable to a nation at war—to **VICTORY!**

Long-lived, dependable AETNA PRODUCTS mean less frequent replacements, increased production and extended machine life. You save for yourself, for your country.

AETNA BALL BEARING MFG. CO.
4600 Schubert Ave., Chicago

Thrust Ball Bearings (Standard and Special) . . . Angular Contact Ball Bearings
. . . Roller Bearings (Special) . . . Ball Retainers . . . Hardened and Ground Washers

New Model Carburetor For Twin Wasp Engines

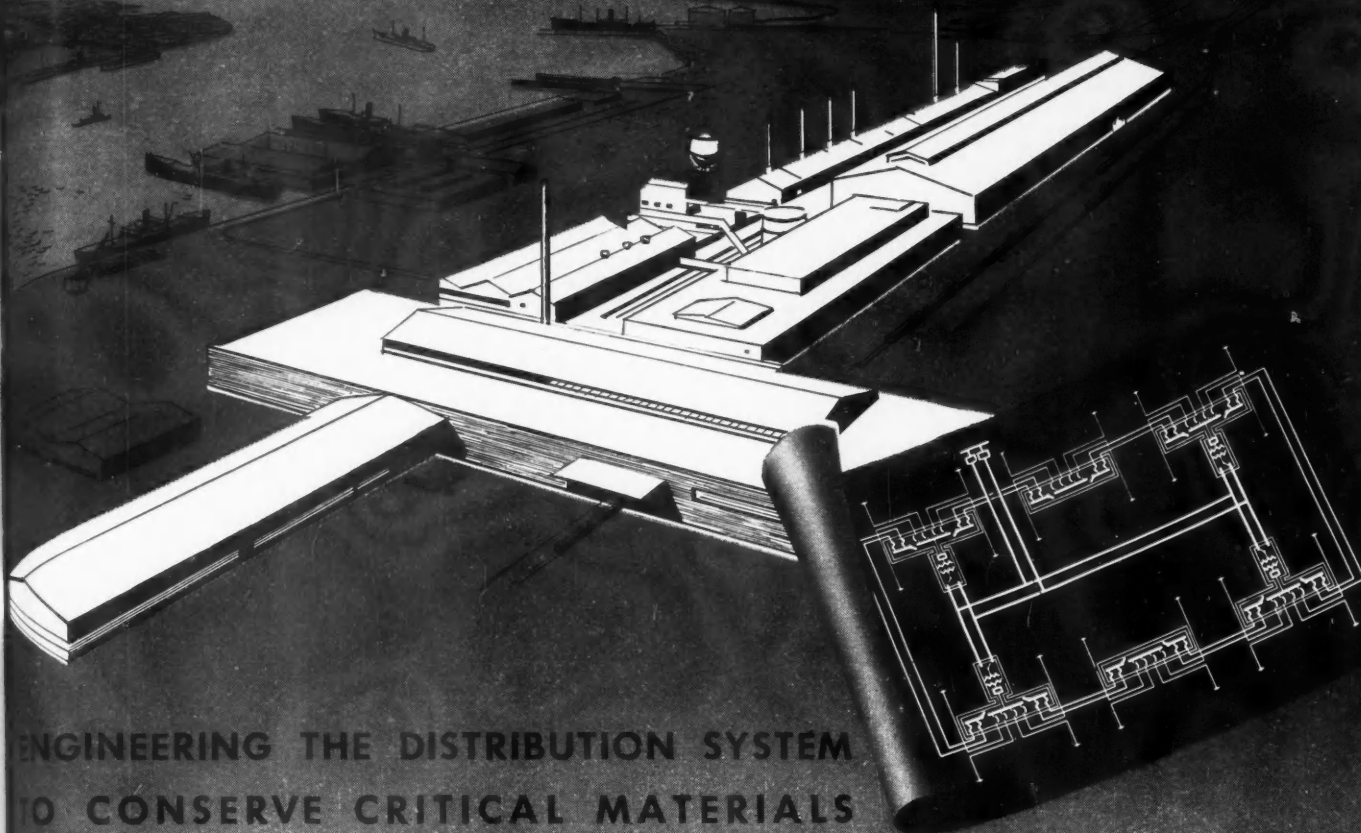
Twin Wasp R-1830 single speed supercharger engines, manufactured by Pratt & Whitney Aircraft, are now being equipped with a new model carburetor which incorporates dual vapor vent floats through the addition of a vapor vent float in the unmetered fuel chamber. Addition of this vapor vent float is said to improve the metering of the carburetor, especially at altitude.

Wm. B. Stout Joins Consolidated Aircraft

Wm. B. Stout, Detroit engineer and inventor, has joined the Consolidated Aircraft Corporation as a technical consultant, and will devote his full time and that of his organization, The Stout Engineering Laboratories, in Dearborn, to creative research work in improving aircraft and allied products and in developing new product ideas. The laboratories in Dearborn will become the Stout Research Division of Consolidated. Announcement of the affiliation was made by T. M. Girdler, Board Chairman of Consolidated. Stout is expected to spend considerable time in San Diego, California, working with Harry Woodhead, President, and I. M. Laddon, Executive Vice President of Consolidated.

Stout was an engineer with Scripps Booth, and Chief Engineer of Packard's Aviation Division before going to Washington as technical advisor to the Government Aircraft Board in the last war. He founded The Stout Engineering Laboratories in 1919, building the "Bat Wing," first U. S. monoplane with internally braced wings. Later he built the trimotor all-metal transport plane for Ford, and established the Stout Air Services, which eventually became a part of United Air Lines. In 1935 he designed the Scarab, a rear engine automobile with individual wheel springing and extreme streamlining. He also designed the railplane, first streamlined, high speed, gasoline driven train in the U. S., constructed from welded steel tubing and duraluminum.

In recent years Stout had been doing developmental work on a light-weight, low cost "Flivver" plane, aiming toward an engine costing only \$100 to develop 100 hp.



ENGINEERING THE DISTRIBUTION SYSTEM
TO CONSERVE CRITICAL MATERIALS

Saved 11 tons of copper

HOW WESTINGHOUSE CAN HELP YOU SAVE TIME • CRITICAL MATERIALS

- **Selecting the Right System**—Wide application experience in all types of industries enables Westinghouse engineers to recommend the distribution system best fitted to your plant.
- **Air-Cooled Transformers**—permit location close to load centers with maximum safety, eliminate expensive vaults.
- **Hipersil**—an exclusive Westinghouse development with $\frac{1}{3}$ more flux-carrying capacity than ordinary silicon steel. Reduces transformer size and weight.
- **Loading by Copper Temperature**—permits use of *all* the transformer capacity, with complete protection against burnouts.
- **Improving Power Factor**—through use of capacitors, can often save installation of new feeder lines. Westinghouse engineers are in a position to make such practical recommendations.

A vital war plant faced the problem of providing reliable power supply. The distribution system originally planned required 70,600 pounds of copper.

By recommending a plant network system custom-fitted to the job, Westinghouse engineers were able to provide greater flexibility with increased sabotage protection—using *only* 48,400 pounds of copper. Result: 22,200 pounds of critical material saved—more than 11 tons.

Westinghouse plans and builds *all* types of distribution systems. Thus broad engineering experience is brought to bear on your particular problem. The final recommendation is based on nature, density and location of load—and critical material saved. All systems recommended are designed to use standard distribution equipment. No time is lost in building special apparatus.

For prompt action, call our local office. Or send for the helpful booklet below. Westinghouse Electric & Mfg. Co., E. Pittsburgh, Pa.

J-94534



UP-TO-DATE FACTS ABOUT DISTRIBUTION SYSTEMS

Keep up-to-date on latest plant distribution systems. Send for this 24-page Book, B-3152, which briefly describes different plant distribution systems, and points out the advantages of each.



Westinghouse **PLANT DISTRIBUTION SYSTEMS**
PLANTS IN 25 CITIES... OFFICES EVERYWHERE

Get Production and Finish

LIKE THIS

AND THIS

AND THIS



1-Automatic Turning and Boring!

Foster Fastermatic Universal Automatic Turret Lathes are pace-setters that produce large quantities of accurately machined parts in minimum time. Feeds and speeds are automatic...the proper feed and the correct surface cutting speed for *each* diameter are automatically controlled. The flexible hydraulic feed system provides separate, independent feeds for each face of the turret. Fastermatics are available in four sizes; also in Platen Type machines.

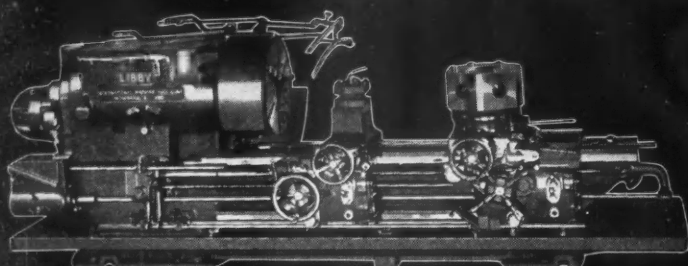
2-Surface Superfinishing!

Foster Superfinishers improve surface finish and remove surface irregularities on such parts as bearings and sliding members. Geometrically improved surfaces of 2 to 3 micro-inches, as measured with a profilometer, are produced with as little as .0002" to .0003" stock removal. Superfinishers are furnished in general purpose and special machines for miscellaneous or production superfinishing; also in attachments for use on engine or turret lathes.

3-Heavy Duty Turning and Boring!

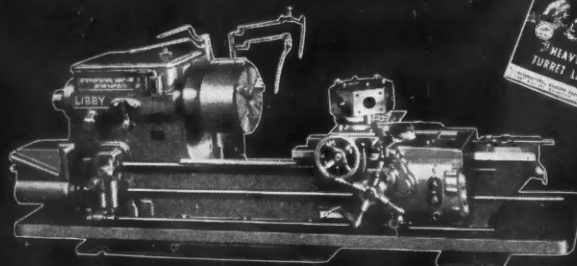
Libby Heavy Duty Turret Lathes are providing manufacturers with accurate, efficient, high production turning of large, heavy work. Close tolerances are assured, even while taking extra heavy cuts. Libby Heavy Duty Turret Lathes are available in a range of six sizes and capacities for every turning and boring requirement; also in Fixed and Adjustable Bed Gap Machines.

LIBBY HEAVY DUTY TURRET LATHE



MODEL NOS. >>> H	1-H	2-H	3-H	4-H	5-H
Swing Over Ways. 18"	24"	27"	29"	32"	36"
Spindle Hole. 5 1/4"	5 1/4"	8 1/4"	10 1/4"	8 1/4"	8 1/4"
	or 6 1/4"	or 6 1/4"	or 10 1/4"	or 12 1/4"	or 12 1/2"
Chuck Dia. 16"	18"	22 3/4"	24"	24"-28"	28"-32"
Turning Length. 56"	56"	72"	72"	72"	72"

FREE: Write today for catalog covering the extensive line of Libby Type "H" Heavy Duty Turret Lathes.



LIBBY ADJUSTABLE BED GAP HEAVY DUTY TURRET LATHES can be furnished in the same sizes as the Type "H" Series listed above. Gap is adjustable from 26" to 56" to suit the particular work at hand.

LIBBY FIXED BED GAP HEAVY DUTY TURRET LATHES are available in the same sizes as the Type "H" Series listed above. Size of gap varies from 26" to 56" in 6" increments.

INTERNATIONAL MACHINE TOOL

FOSTER DIVISION, ELKHART, INDIANA

3 Vital Functions of INTERNATIONAL MACHINE TOOLS For War and Postwar Machine Production

AUTOMATIC turning and boring...surface superfinishing
...heavy duty turning and boring...

Today, these three vital functions are being performed with consistent efficiency and precision by International Machine Tools in numerous plants throughout the Nation. While every one of these functions is essential to industry in our war effort, the same efficiency and precision must also be maintained in the peace to follow!

Now and in the future, you can depend on International Machine Tools for the speed and precision your machining operations demand.

Write the **FOSTER DIVISION** for FREE catalogs and data on Fastermatic Universal Automatic Turret Lathes and Chucking Tools, Superfinishing Machines and Attachments, and Barker Wrenchless Chucks and Vises.

Write the **LIBBY DIVISION** for FREE catalogs and data on Libby Heavy Duty Turret Lathes and Chucking Tools, and Fixed and Adjustable Bed Gap Heavy Duty Turret Lathes.

Foster and Libby Engineers will be glad to make suggestions, specific recommendations and estimates. There is no obligation. Write today.

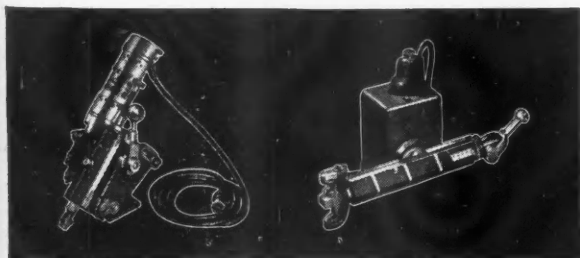
INTERNATIONAL MACHINE TOOL CORPORATION

FOSTER DIVISION

1106 Beardsley Ave.
Elkhart, Indiana

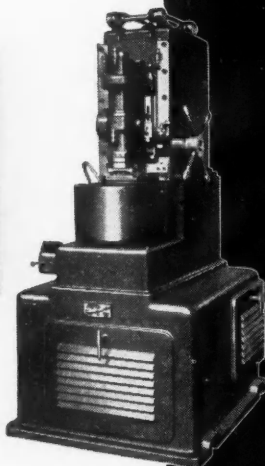
LIBBY DIVISION

1132 West 21st St.
Indianapolis, Indiana



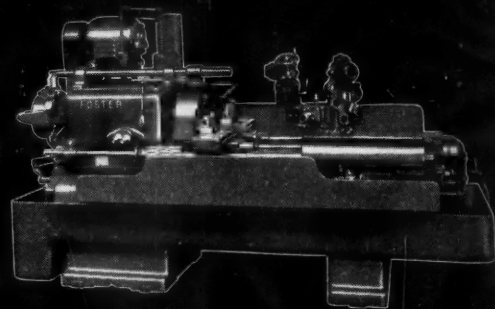
FOSTER SUPERFINISHING ATTACHMENTS

Furnished in four different sizes for mounting on cross slide of engine lathes or turret lathes. The only additional equipment necessary when performing superfinishing operations with these attachments is a lubricant supply for the stone. This equipment, consisting of pump, reservoir and necessary piping, can also be furnished.

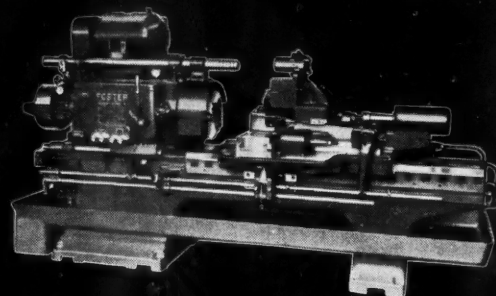


FOSTER FLAT SURFACE SUPERFINISHERS—Superfinishes flat surfaces up to 10" in diameter. Work is held on a suitable fixture or magnetic chuck. Available as a special machine for large work. For small work a flat surface superfinishing attachment can be furnished for the General Purpose Superfinisher (above). Pump, reservoir and piping included.

FOSTER FASTERMATIC UNIVERSAL AUTOMATIC TURRET LATHES



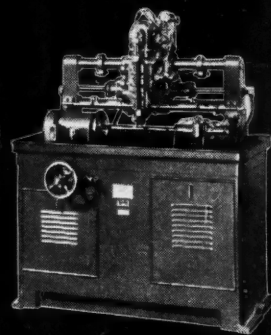
MODEL NOS.	→ 1-FU	2-FU	3-FU	4-FU
Swing Over Bed	21"	25 1/4"	28 1/4"	35 1/4"
Turret Feed Length	11" max.	12 9/16" max.	12 1/2" max.	18 1/16"
Cross Slide Travel	3 1/4"	3 5/8"	5"	6 5/8"
Spindle to Turret Face	41 11/16"	50 3/16"	53"	67 1/2"
Spindle to Turret Face at Start of Feed	36 11/16" max.	44 3/4" max.	47 1/2" max.	61 1/4"



FOSTER PLATEN TYPE FASTERMATIC UNIVERSAL AUTOMATIC LATHES—Platen Type Chucking Machines are available in the same sizes as the Fastermatic Indexing Turret Type listed above. Platen types have specially designed tool carrying units, including front and rear cross slide and a main slide—all mounted on a platen.

FREE: Write today for catalog covering the complete line of Foster Fastermatic Universal Automatic Turret Lathes.

FOSTER SUPERFINISHING MACHINES



FOSTER GENERAL-PURPOSE SUPERFINISHERS—4, 18" and 4" x 36"—For superfinishing a wide range miscellaneous cylindrical parts, or for high production. This machine permits the development of extremely fine surfaces from work produced by ordinary cutting tools grinding equipment. It produces a superfinish on a turn surface by the use of both coarse and fine abrasive stone.



FREE: Write today catalog covering Foster Superfinishing Machines and Attachments.

INTERNATIONAL MACHINE TOOL CORPORATION

LIBBY DIVISION, INDIANAPOLIS, INDIANA



New Production Equipment

(Continued from page 43)

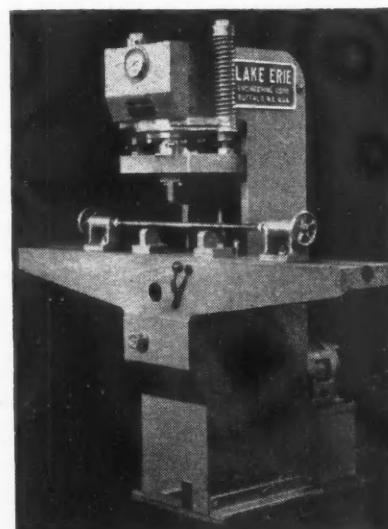
A POWER driven, safety screw type airplane jack is announced by the Lamson Corporation, Syracuse, N. Y. This jack is self-locking in any position, can be turned in a small space and permits tilting the plane for ease in assembly. Two types are available, one for the wing and one for the tail of the plane, the principal difference being the length of the arm extension. The wing jack has a maximum lift of 60 in. and a capacity of 10,000 lb to 12,000 lb with

a 15 in. arm. The tail jack has a maximum lift of 73 in. and a capacity of 500 lb to 1000 lb with a 39 in. arm. Both models have a lifting speed of 2 fpm.

A SENSITIVE quick-acting shaft straightening press complete with anvils and centers for testing is announced by the Lake Erie Engineering Corporation, Buffalo, N. Y. The pumping unit is self-contained in the base of the press and provides 20 ton capac-

ity. The ram operates at high speed and is arranged with quick return springs.

Combination hand lever and foot pedal control are so arranged that either may be used independently. Maximum

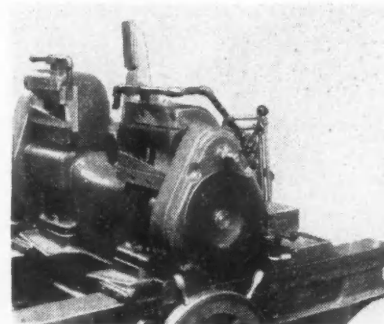


Shaft straightening press built by Lake Erie Engineering Corporation.

down stroke of the ram is adjusted by the control located on the yoke. Pressure control hand-wheel is mounted on the front of the main pedestal. The main frame is built up of rolled steel side plates electrically welded into one solid unit.

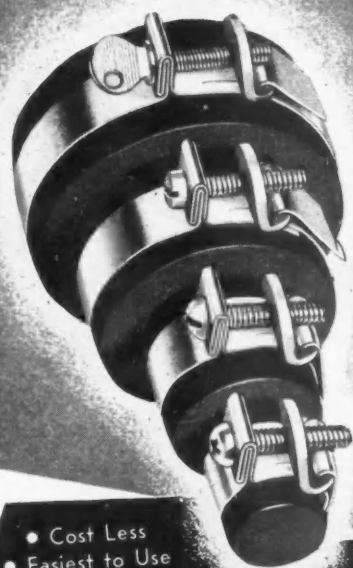
THE LANDIS MACHINE COMPANY, Waynesboro, Pa., has recently developed a hydraulically controlled cutting-off unit. This device is intended to replace the standard carriage, crossrail and die head of the Landis mill type pipe threading machines where these machines are to be used strictly for the cutting-off operation and when maximum operating efficiency is desired.

The cutting-off device comprises two high speed steel cutting-off tools mounted in massive slides for maximum rigidity. These tool slides function through a hydraulic cycle which provides rapid traverse of the tools to the work and rapid retraction of the tools after the cutting-off operation is completed. The



The Landis hydraulically controlled cutting-off unit.

IDEAL FOR ALL HOSE AND GENERAL CONNECTIONS



**ALLSIZE
UNIVERSAL
HOSE CLAMPS**

ARE

Completely Universal

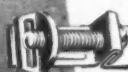
- Cost Less
- Easiest to Use
- 100% Self-Locking

Approved Self-Locking Clamps that accommodate any range of diameter sizes.

Eliminate Your Production Bottleneck With ALL-SIZE CLAMPS.. Buy ONE Length —Replace 100 Different Preformed Clamps.

- A single All-Size Clamp will replace more than a hundred sizes of preformed clamps — reducing your clamp inventory and assuring the right size clamp on hand when needed!
- This powerful, completely self-locking clamp has been tested and proved superior for both production and service work. It has sufficient take-up for use on synthetic rubber hose, and it can be installed around, or removed from, connected lines. It also is usable over and over again on either larger or smaller sizes.
- All-Size Clamps come flat in any length to fit any desired range of diameter sizes. They are acknowledged superior to the strongest clamps made — but cost much less and are infinitely easier to use! . . .

If you now use clamps for hose or general connections learn how the ALL-SIZE Clamp can save time, labor and money for you!



ALLSIZE

**SEND TODAY
FOR FREE
SAMPLES
AND PRICES**

CENTRAL EQUIPMENT CO.

1018 SO. WABASH AVENUE * CHICAGO, ILLINOIS



Vital as Hell!

Hydraulic systems carry and control the life blood of today's fighting aircraft—they must not fail!

Dirt, moisture, or corrosion in lines or units—or any damage to threads or tapered surfaces of connecting links will cause failures.

Vital Tubing Seal-Caps, Seal-Plugs, Flex-Caps, and Boss-Plugs completely protect hydraulic lines and unit fittings in all stages of assembly prior to flight.

Where others might chip or be sucked into lines, metal Tubing Seal-Caps and Plugs have no particles to chip off and enter tubing—can be *re-used* many times—do not deteriorate—are not affected by contact with chemical agents—can be installed in much less time than other devices.

Write today, for the new file-size booklet, "Tubing and Pipe Protection Methods," describing these vital products.

TUBING SEAL-CAP, INC.

215 W. 7th STREET, LOS ANGELES
East. Representative, 428 New Center Bldg., Detroit



SEAL-CAP



SEAL-PLUG



BOSS-PLUG



FLEX-CAP

Used by Douglas, Boeing, North American, Northrop, Vought, Interslate, Murray Corp., Paul G. Wagner and many others.

forward and return movements of the tool slide are controlled by a single lever. Complete operator control of the hydraulic cycle provides variable feed rates for the cutting-off tools and adjustments of the length of travel of these tools for different thicknesses of tubing. A single control valve adjusts the rate of feed for both the front and rear cutting-off tools.

A NEW 6 in. rotary table, small enough to go into usually inaccessible places, is now in production at the Duro Manufacturing Company, Los Angeles, Cal. Fast rotation is possible, as the

worm gear ratio is 60 to 1, giving a 6 deg rotation for one turn of the crank. An eccentric adjustment is provided to eliminate back-lash between the worm and gear and the beveled dial on the worm shaft is graduated to tenths of a degree. A "T" lock screw is provided for fixing the position of the table. The height of the assembly is 2½ in. and the weight is 14½ lb.

A N ABRASIVE belt backstand idler for use in conjunction with abrasive belts, which features a new spring-loaded adjusting screw and hand wheel, has been announced by Hammond Machin-



The Duro rotary table.

ery Builders, Inc., Kalamazoo, Mich. The Hammond No. 3 backstand idler utilizes a surface coated abrasive belt running over contact the wheel of the grinder or polisher with which it is employed. The heavy duty type ball bearing pulley is provided with adjustments for belt positioning and tracking and



ONLY LAPPING *As Strom Does It* CAN PRODUCE SUCH PRECISION

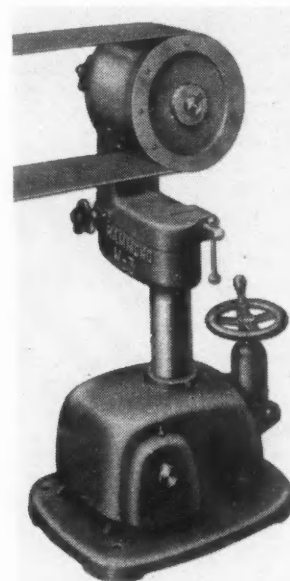
Strom Steel Balls possess a degree of surface smoothness and sphericity that has never been equalled in any other regular grade of ball. Such precision is exclusive with Strom because it can be attained only through a series of lapping operations such as are standard practice in the Strom plant.

Physical soundness, correct hardness, size accuracy and sphericity are guaranteed in all Strom Balls.

Other types of balls—*stainless steel, monel, brass and bronze*, are also available in all standard sizes. Write for complete details.

Strom STEEL BALL CO.
1850 So. 54th Avenue, Cicero, Ill.

The largest independent and exclusive Metal Ball Manufacturer



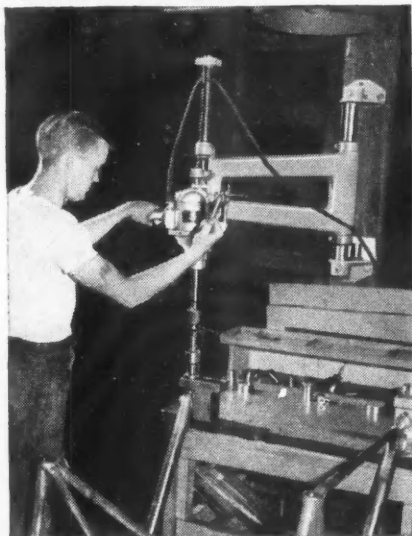
The Hammond No. 3 abrasive belt backstand idler.

the machine can be used either right or left hand by turning the idler wheel head and column 180 deg and locking in position.

DESIGNED to permit easy handling of portable welding guns, as well as to allow reaching work from as long a distance as possible, the type P-1-R radial portable gun welder is now in production at Sciaky Brothers, Chicago, Ill. The weight of the gun and cables is balanced by a balancing apparatus suspended from the monorail, along which it is free to move as the gun is moved. The secondary cables are mounted on two horizontal, water-cooled copper bars of heavy section, which are articulated and balanced on a horizontal axis. The copper bars make pos-



WAR WON'T WAIT so, around a Black & Decker 1/2" Utility Drill, Aircraft Mechanics, Inc., built this special device for dressing the side edges of bearings. The device pulls up instead of bearing down.



IN A RADIAL ARM of their own design, Aircraft Mechanics, Inc., uses another Black & Decker Drill to do the work of a 48" radial drill press, for drilling operations on aircraft engine mounts.



IN ANOTHER "HOME MADE" JIG, on which a hand-turned thumbscrew exerts a pulling up action, a Black & Decker Utility Drill is used for dressing—or "spot facing"—the under sides of bearings.

When machine tools can't be had

Black & Decker Tools do the Job!



THEY COULDN'T GET THESE

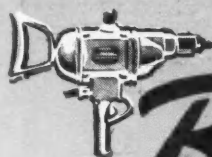
SO HERE'S WHAT THEY DID!

AIRCRAFT MECHANICS, INC., needed equipment to start quantity production of welded steel structures for airplane engine mounts and landing gear... they couldn't get machine tools for months. But that didn't stop 'em! By combining ingenuity with Black & Decker Portable Electric Tools, they built their own special equipment—saved 3 to 4 months starting production. The pictures here tell the story.

The case of Aircraft Mechanics, Inc., is not unusual. We have

just published a booklet showing how other ingenious war producers have combined brains with Black & Decker Tools—and built special equipment to do special jobs when machine tools were not available. It's called "They Used Their Heads"—and a copy is yours for the asking. Write: The Black & Decker Mfg. Co., 781 Penna. Ave., Towson, Md.

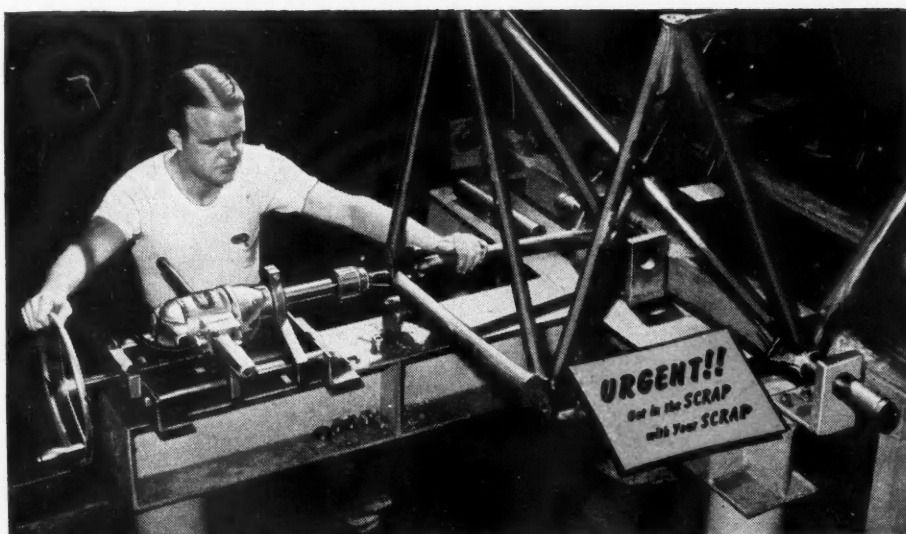
For Expert Help on any tooling problem, phone your nearby Black & Decker Distributor. He's ready to serve you quickly—with expert tool information—or as a dependable source of supply.



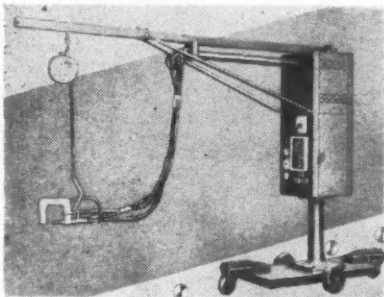
LEADING DISTRIBUTORS EVERYWHERE SELL

Black & Decker

PORTABLE ELECTRIC TOOLS



"IT'S TOUGH ON THE DRILLS—BUT THEY CAN TAKE IT!" says Aircraft Mechanics, Inc. Here they have used a Black & Decker Utility Drill in building their own horizontal drill press. According to their report, this outfit is very fast and is doing the same work as a big 60" radial drill press. A new free booklet—called "They Used Their Heads"—illustrates more such ingenious adaptations of B & D Tools. For a copy address: The Black & Decker Mfg. Co., Towson, Md.



The Sciaky portable gun welder.

sible the use of the gun at a distance from the equipment, although the cables are relatively short. The use of com-

paratively light cables is made possible by the low electrical losses in the copper bars.

The control cabinet, the welding transformer, the monorail and the copper bars are built as a self-contained unit. This unit is mounted on a stationary column and pivots on a vertical axis by means of two bearings mounted inside the column. This construction permits a horizontal movement of the welding gun over a radius of about 10½ ft.

HISTORY'S OLDEST FABRIC—MAKING HISTORY TODAY



Felt Stops Desert Sand From Stopping Planes, Tanks, Jeeps

Next to the actual enemy, the greatest foe of the Armed Forces fighting on desert terrain is sand. It gets into the vitals of precision parts to cause breakdowns, delays, and frequent overhauls.

Western Felt products in the form of grommets, washers, gaskets, etc. are widely used to lock out sand and prevent damage.

In many other forms... insulation, weather-stripping, lubrication wicks, etc. ...felt is one of today's most useful materials. Draw freely on Western's 42 years' experience in fabricating felt to closest specifications. Write us today.

WESTERN FELT WORKS
Chicago: 4035-4117 Ogden Ave.
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The Acadia Synthetic Division of Western Felt are processors of Plastics (Sheets, Extrusions, Tubings, Molded Parts) and Synthetic Rubber. Write for information.

WESTERN

Largest Independent Manufacturers and Cutters of Hair, Wool and Jute Felts

GROMMETS • CHANNELS • WASHERS • GASKETS • PADS

Felt

WICKS • INSULATION • ETC.

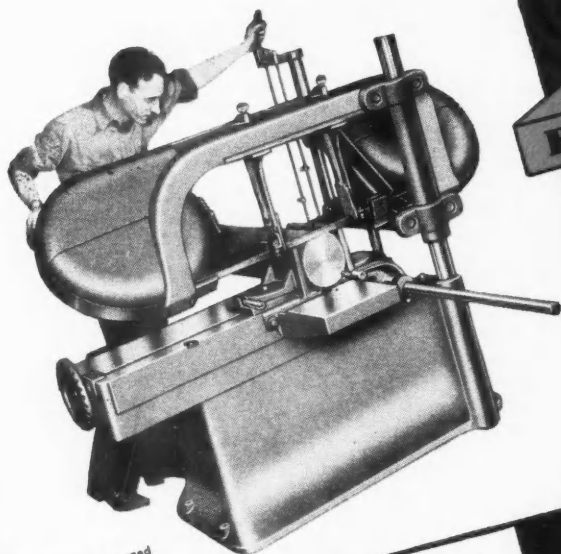
BOTH the interior and exterior surfaces of 500 lb semi-armor piercing and demolition bombs are cleaned in the Wheelabrator bomb cleaning machine made by the American Foundry Equipment Company, Mishawaka, Ind.



American Wheelabrator bomb cleaning machine.

Operation of the machine is entirely automatic. From the conveyor, the bomb falls into a loading device which lifts it into a hanger at the front of the machine. As the hanger, carrying the bomb, enters the blasting chamber, it is indexed and rotated over a lance type air blast nozzle which enters and scours the interior of the bomb with steel abrasive. At another station the bomb is rotated in front of an airless Wheelabrator unit, the blast of which completely covers the exterior of the bomb. As the cleaned bomb revolves to the front of the cabinet, it is removed and another one placed in the hanger. With a few minor changes, this type machine may be used for cleaning a wide range of sizes and types of shells.

THE NEW Lombard universal milling machine, which features ease of operation and a wide range of feeds and speeds, is now in production at the Lombard Governor Corp., Ashland, Mass. Three ranges of spindle speeds are provided: 29 to 119 rpm, 115 to 475 rpm and 460 to 1900 rpm. The four ranges of feeds are ⅜ in.-15 in., ½ in.-20 in., ¾ in.-30 in. and 1 in.-40 in. The table has a work holding surface of 12 in. by 53 in. with 28 in. horizontal pow-



Wells V-12, the rugged new heavy duty saw which features hydraulically controlled feed and lift.

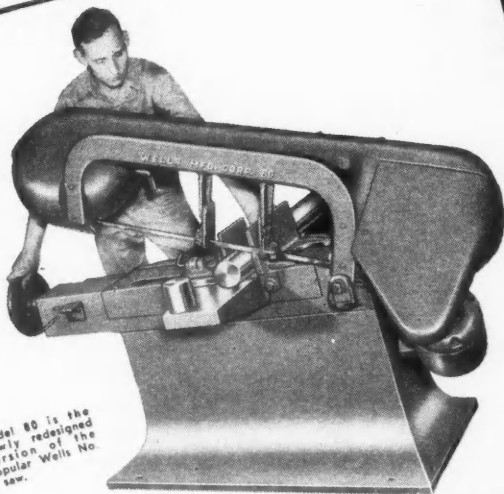
**FAST-ACCURATE
VERSATILE**

WELLS

Continuous Metal Cutting BAND SAWS

for
PRODUCTION • TOOL ROOM
MAINTENANCE • GENERAL UTILITY

V-12



Model 80 is the newly redesigned version of the popular Wells No. 8 saw.

SERIES
80

SPECIFICATIONS

SPECIFICATIONS	V-12	No. 80
Capacity: Rectangular	13" x 16"	8" x 16"
(Special bowed guides)		5" x 24"
Rounds	13" dia.	8" dia.
Speeds: Feet per minute	33, 94, 148	60, 90, 130
Motor Size	3/4 H.P.	1/2 H.P.
Swivel Vise	to 45°	to 45°
Blade Size	13' 7 3/4" x .032"	11' 6" x .031"
Height to top of table	24"	25 1/2"
Width of Bed	12"	10 1/4"
Drive	"V" Belt	"V" Belt
Floor Space	73" x 30"	9' x 6'

WITH Wells Metal Cutting Band Saws you can apply the advantages of continuous cutting action to virtually all kinds of metal cutting jobs. Almost all metals in all shapes are cut quickly and accurately at minimum expense. Designed to provide maximum efficiency for saws of this type, Wells Metal Cutting Band Saws offer you these advantages:

Capacity is the greatest of any saw for the money.

Simplicity is engineered into the machine to give a lifetime of service.

Three speeds of the CORRECT amount of feet per minute assure most efficient cutting and long blade life.

Controlled feed is positive and accurate.

Heavy I beam holds and brings fully adjustable guides close up to the work for accurate cutting.

No coolant required even when cutting tool steels.

Heavy, sturdy construction—no vibration.

And a host of other details that mean better metal cutting at lower cost.

Wells Has Established Dealership

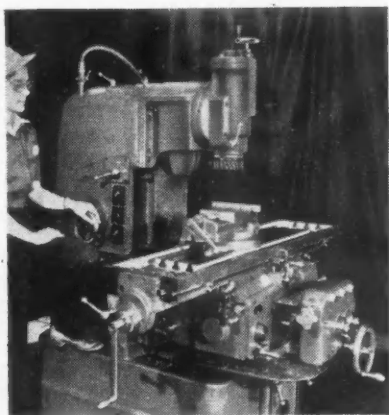
**WELLS MANUFACTURING
CORP., THREE RIVERS, MICH.**

Write for complete details

WELLS MANUFACTURING CORPORATION

Wells METAL CUTTING BAND SAWS

101 JEFFERSON STREET • THREE RIVERS, MICHIGAN

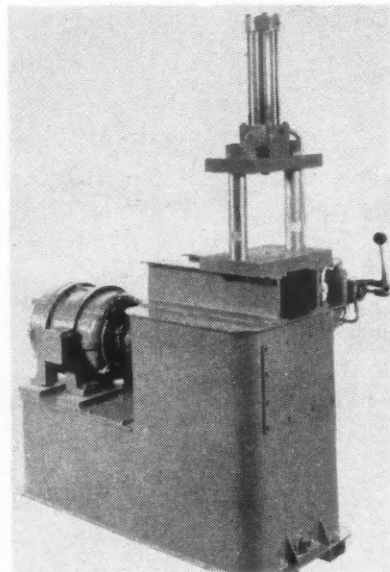


The Lombard universal milling machine.

er feed, 10 in. power cross feed and 4 in. vertical feed. The vertical head is hinged to the column for quick change-over from horizontal to vertical milling. The machine will be supplied in three models, horizontal, vertical or universal.

A HYDRAULIC arbor press, rated at 6 tons, is being manufactured by Hydraulic Machinery, Inc., Detroit, Mich. It has an 8 in. stroke and an

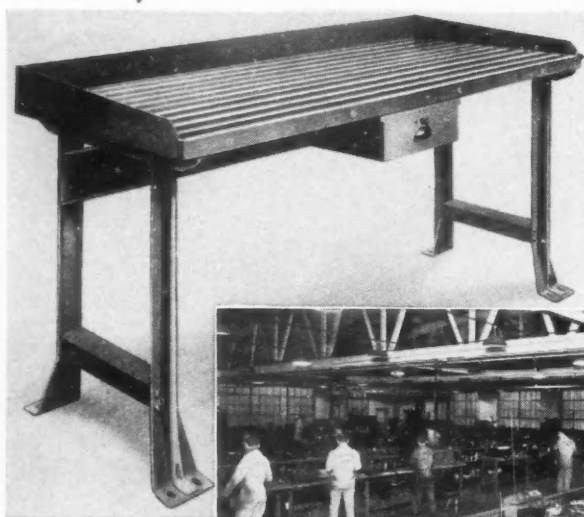
opening of 20 in., both vertically and horizontally. The power unit and the press are combined as a single assembly; the former, reinforced at the top by two I-beams, serving as a base for the press. A lever operated valve determines the direction and speed of movement, the closing speed being 3.4 ipm. A Vickers pump, directly connect-



New 6 ton hydraulic arbor press built by Hydraulic Machinery, Inc.

ed to a 5 hp motor, is standard equipment. Arbor press and power unit combined occupy 27 in. x 42 in. floor space.

"How long is a work bench?"



Right: A shop set up with continuous lines of "Hallowell" Work Benches.



Left: Fig. 928 "Hallowell" Work Bench with laminated wood top. Pat'd and Pats. Pending. Drawer is extra.

Let's answer it this way . . .

HALLOWELL

SHOP EQUIPMENT

. . . includes a line of ready-made work benches which come in standard lengths of 3, 4½, 5, 6, 8, 9 and 10 feet. However, these are designed so that any number can be joined end to end to provide a continuous work-bench of any desired length. Further, the legs are made in 5 heights and widths, an exclusive "Hallowell" feature. In the 1367 "Hallowell" bench combinations you will find just the right type for your needs. Our catalog shows a comprehensive group of them. Send for a copy.

STANDARD PRESSED STEEL CO.

JENKINTOWN, PENNA. BOX 561

— BRANCHES —


BOSTON • DETROIT • INDIANAPOLIS • CHICAGO • ST. LOUIS • SAN FRANCISCO

Flooring Material for Buses

A new industrial flooring, developed especially for use in buses and streetcars, has been introduced by the Armstrong Cork Company, Lancaster, Pa. Known as Traffex, this new flooring material is said to have exceptional wear-resistant qualities. It is compounded from materials which are not subjected to priority restrictions and is recommended for use under all climatic and traffic conditions. The new product is supplied in three plain colors: brown, red, and black, and in two thicknesses; 3/16 in. and ¼ in.

Fire Extinguisher for Incendiary Bombs

A new pump tank fire extinguisher for use on incendiary bomb fires, has been designed by the American-LaFrance-Foamite Corporation, Elmira, N. Y. In compliance with the latest requirement of the Office of Civilian Defense, this pump tank produces a straight stream and not a spray. It is made in 2½ gal and 5 gal sizes and has a range of 30 to 40 ft. Both sizes are approved by the Underwriters' Laboratories with a Class A-1 rating, under the Emergency Alternate Specifications.



AMERICA'S ONLY RADIAL
AIR-COOLED DIESEL ENGINE

MORE THAN HORSEPOWER

FOR TANKS, PLANES and SHIPS

No Fire Hazard
Lower Fuel Consumption
Increased Striking Range
Greater Stamina

Dependable Operation
Instant Response to the
Throttle
No Ignition System

Lower Cost of Fuel
Constant Torque at All
Speeds
No Radio Interference

ESTABLISHED



1919

Guiberson U.S.A.

GUIBERSON DIESEL ENGINE COMPANY

Dallas, Texas

★ THE GUIBERSON CORPORATION

Aircraft and Heater Division

MEN

(Continued from page 47)

Ellis Travers, formerly manager of the Detroit office of Ruthrauff & Ryan, Inc., has been appointed director of advertising and public relations for the manufacturing division of the Crosley Corp.

Harry L. Horton, formerly regional manager for the Chevrolet Motor Division of GM, has been promoted from major to lieutenant-colonel in the First Air Service Area Command.

William P. Edmunds, industrial relations director for Standard Oil Co. of Ohio, has been appointed manpower director for Michigan, Ohio and Kentucky by the War Manpower Commission.

Howard Hallas, formerly on the public relations staff of Nash-Kelvinator Corp., has joined Carl Byoir & Associates in the

Chicago office to work on the Pullman account.

Raymond S. Livingstone has been elected vice president in charge of personnel of Thompson Products, Inc. He has been in charge of employment, industrial training and labor relations.

Fred L. Black, former advertising manager of Ford Motor Co. and more recently with the Detroit office of OWI, has been appointed commercial agent in the Detroit office of the Dept. of Commerce.

The Lubrication Equipment Industry Advisory Committee appointed by WPB is composed of J. E. Allen, Aero Equipment Corp., Bryan, Ohio; R. J. Gits, Gits Bros. Mfg. Co., Chicago; Lee Gray, Gray Co., Inc., Minneapolis; Frank A. Hiter, Alemite Division of Stewart-Warner Corp., Chicago; Foster Holmes, Lincoln Engineering Co., St. Louis; Edwin G. Hull, Trabon Engineering Corp., Cleveland; A. J. Jennings, the

Farval Corp., Cleveland, and Edward J. Kocher, Bijur Lubricating Co., Long Island City, N. Y.

Curtis A. Pringle, former assistant manager of the Ford Motor Co. rubber plantation in Brazil, has been appointed by the government as field director of an organization to search the jungles of the Amazon River basin for natural rubber.

Alfred P. Sloan, Jr., board chairman of General Motors Corp., has been elected a director of J. P. Morgan & Co.

Lee Anderson, former president of the advertising agency bearing his name until its dissolution early in 1942, has been appointed civilian advisor to Brig.-Gen. Alfred R. Glancy, chief of the Tank-Automotive Center, Detroit.

Obituary

John J. Hebor, 50, Small Tool and Gage manager of the Cleveland office of Pratt & Whitney, died Dec. 2. At the age of 17, Mr. Hebor came to Pratt & Whitney in Hartford, Conn., where he worked in the various departments of the Small Tool Division until 1915. In that year he was transferred to the Pratt & Whitney Cleveland office. In a few years he rose to become manager of Small Tools and Gages Sales in that office, and had held that position until the time of his death.

Charles W. Mears, 68, died Dec. 9 at Cleveland, Ohio. He was one of the nation's pioneer automobile advertising men and the author of many advertising books.

Hugh Purdy, 66, who was connected with Buck & Hickman, Ltd., agents in England for Pratt & Whitney, died Dec. 3 in England. Mr. Purdy served his apprenticeship at Pratt & Whitney in Hartford, Conn., starting Feb. 21, 1893. He worked at the Hartford plant until 1900, when he was sent abroad to join Mr. Pratt at the Paris Exposition. He remained to travel all over Europe as a Pratt & Whitney representative. Eventually Mr. Purdy established himself with Buck & Hickman and maintained this connection until his death.

David S. Youngholm, 53, who was vice-president of the Westinghouse Electric & Manufacturing Company, in charge of the company's Lamp Division, Bloomfield, N. J., died recently from a sudden heart attack. Since October, 1937, Mr. Youngholm had been a director and vice-president of the Bryant Electric Company, Bridgeport, Conn. He also was a director of the Westinghouse Electric Supply Company.

Changes of Address

Pump Engineering Service Corporation advises that the address of PESCO administrative, sales and accounting offices becomes 11610 Euclid Avenue, Cleveland, Ohio. PESCO purchasing, production and engineering departments remain at 12910 Taft Avenue, Cleveland, Ohio.

Micromatic Hone Corporation requests that all its mail be addressed to its new plant, located at 8100 Schoolcraft Avenue, Detroit, Mich.



IN thousands of varied shapes "fighting wire" is on the war fronts. In bombs and shells; in tanks and guns and planes; in equipment and war material of many types, you'll find wireforms and springs doing a thousand-and-one vital jobs.

Above, you see a few of the many Accurate-made special wire shapes which are parts of fighting equipments. They're produced in huge quantities to Accurate precision standards — under rigid control from raw materials to inspected finished products.

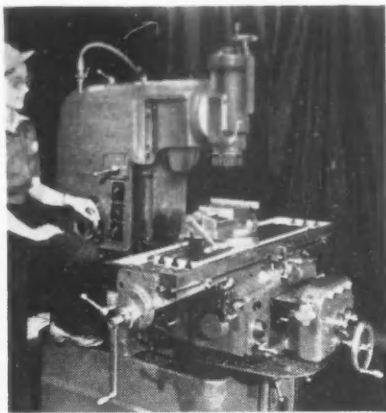
Accurate "know-how", based on experience and specialization, can help you solve your production problems that involve springs and wireforms. Tell us what you need and when you need it—it's as simple as that.

**Accurate
Springs**

Free "Handbook on Springs". Send for your copy today. It is informative, compact, handy to use.

ACCURATE SPRING MFG. CO., 3811 W. Lake St., Chicago, Ill.

**WHAT
SPECIAL
WIREFORMS
DO YOU
NEED?**

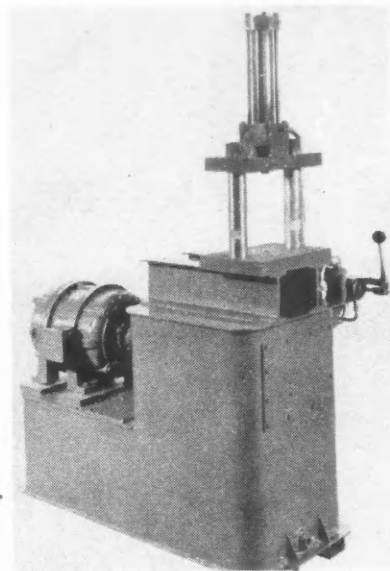


The Lombard universal milling machine.

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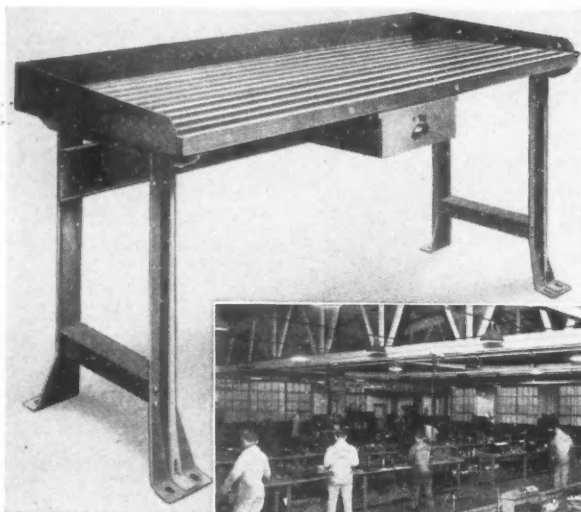
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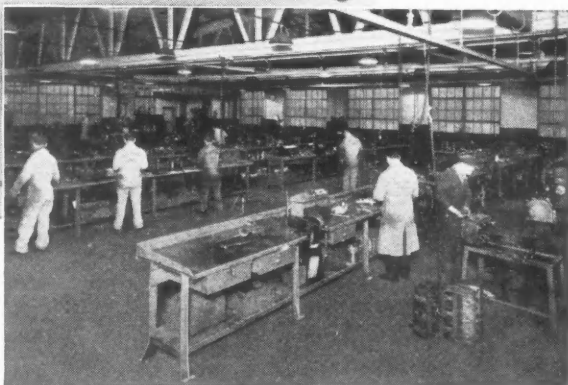
Fire Extinguisher for Incendiary Bombs

A new pump tank fire extinguisher for use on incendiary bomb fires, has been designed by the American-LaFrance-Foamite Corporation, Elmira, N. Y. In compliance with the latest requirement of the Office of Civilian Defense, this pump tank produces a straight stream and not a spray. It is made in 2 1/2 gal and 5 gal sizes and has a range of 30 to 40 ft. Both sizes are approved by the Underwriters' Laboratories with a Class A-1 rating, under the Emergency Alternate Specifications.

"How long is a work bench?"



Right: A shop set up with continuous lines of "Hallowell" Work Benches.



Left: Fig. 928 "Hallowell" Work Bench with laminated wood top. Pat'd and Pats. Pending. Drawer is extra.

Let's answer it this way . . .

HALLOWELL

SHOP EQUIPMENT

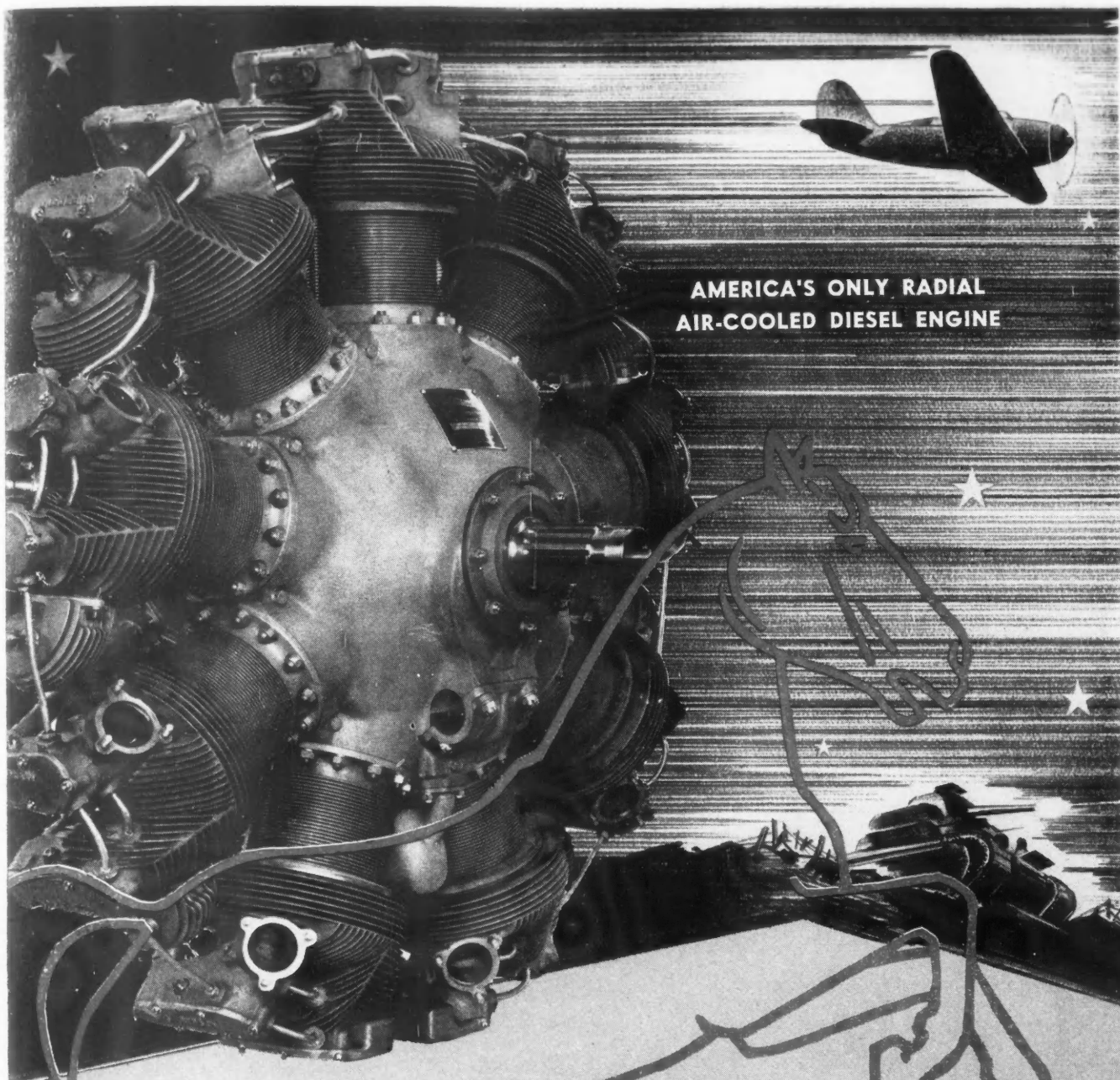
. . . includes a line of ready-made work benches which come in standard lengths of 3, 4 1/2, 5, 6, 8, 9 and 10 feet. However, these are designed so that any number can be joined end to end to provide a continuous work-bench of any desired length. Further, the legs are made in 5 heights and widths, an exclusive "Hallowell" feature. In the 1367 "Hallowell" bench combinations you will find just the right type for your needs. Our catalog shows a comprehensive group of them. Send for a copy.

STANDARD PRESSED STEEL CO.

JENKINTOWN, PENNA. BOX 561

— BRANCHES —

BOSTON • DETROIT • INDIANAPOLIS • CHICAGO • ST. LOUIS • SAN FRANCISCO



AMERICA'S ONLY RADIAL
AIR-COOLED DIESEL ENGINE

MORE THAN HORSEPOWER

FOR TANKS, PLANES and SHIPS

No Fire Hazard
Lower Fuel Consumption
Increased Striking Range
Greater Stamina

Dependable Operation
Instant Response to the
Throttle
No Ignition System

Lower Cost of Fuel
Constant Torque at All
Speeds
No Radio Interference

ESTABLISHED 1919

Guiberson U.S.A.

GUIBERSON DIESEL ENGINE COMPANY ★ THE GUIBERSON CORPORATION
Dallas, Texas Aircraft and Heater Division

MEN

(Continued from page 47)

Ellis Travers, formerly manager of the Detroit office of Ruthrauff & Ryan, Inc., has been appointed director of advertising and public relations for the manufacturing division of the Crosley Corp.

Harry L. Horton, formerly regional manager for the Chevrolet Motor Division of GM, has been promoted from major to lieutenant-colonel in the First Air Service Area Command.

William P. Edmunds, industrial relations director for Standard Oil Co. of Ohio, has been appointed manpower director for Michigan, Ohio and Kentucky by the War Manpower Commission.

Howard Hallas, formerly on the public relations staff of Nash-Kelvinator Corp., has joined Carl Byoir & Associates in the

Chicago office to work on the Pullman account.

Raymond S. Livingstone has been elected vice president in charge of personnel of Thompson Products, Inc. He has been in charge of employment, industrial training and labor relations.

Fred L. Black, former advertising manager of Ford Motor Co. and more recently with the Detroit office of OWI, has been appointed commercial agent in the Detroit office of the Dept. of Commerce.

The Lubrication Equipment Industry Advisory Committee appointed by WPB is composed of **J. E. Allen**, Aro Equipment Corp., Bryan, Ohio; **R. J. Gits**, Gits Bros. Mfg. Co., Chicago; **Lee Gray**, Gray Co., Inc., Minneapolis; **Frank A. Hiter**, Alemite Division of Stewart-Warner Corp., Chicago; **Foster Holmes**, Lincoln Engineering Co., St. Louis; **Edwin G. Hull**, Trabon Engineering Corp., Cleveland; **A. J. Jennings**, the

Farval Corp., Cleveland, and **Edward J. Kocher**, Bijur Lubricating Co., Long Island City, N. Y.

Curtis A. Pringle, former assistant manager of the Ford Motor Co. rubber plantation in Brazil, has been appointed by the government as field director of an organization to search the jungles of the Amazon River basin for natural rubber.

Alfred P. Sloan, Jr., board chairman of General Motors Corp., has been elected a director of J. P. Morgan & Co.

Lee Anderson, former president of the advertising agency bearing his name until its dissolution early in 1942, has been appointed civilian advisor to Brig.-Gen. Alfred R. Glancy, chief of the Tank-Automotive Center, Detroit.

Obituary

John J. Hebor, 50, Small Tool and Gage manager of the Cleveland office of Pratt & Whitney, died Dec. 2. At the age of 17, Mr. Hebor came to Pratt & Whitney in Hartford, Conn., where he worked in the various departments of the Small Tool Division until 1915. In that year he was transferred to the Pratt & Whitney Cleveland office. In a few years he rose to become manager of Small Tools and Gages Sales in that office, and had held that position until the time of his death.

Charles W. Mears, 68, died Dec. 9 at Cleveland, Ohio. He was one of the nation's pioneer automobile advertising men and the author of many advertising books.

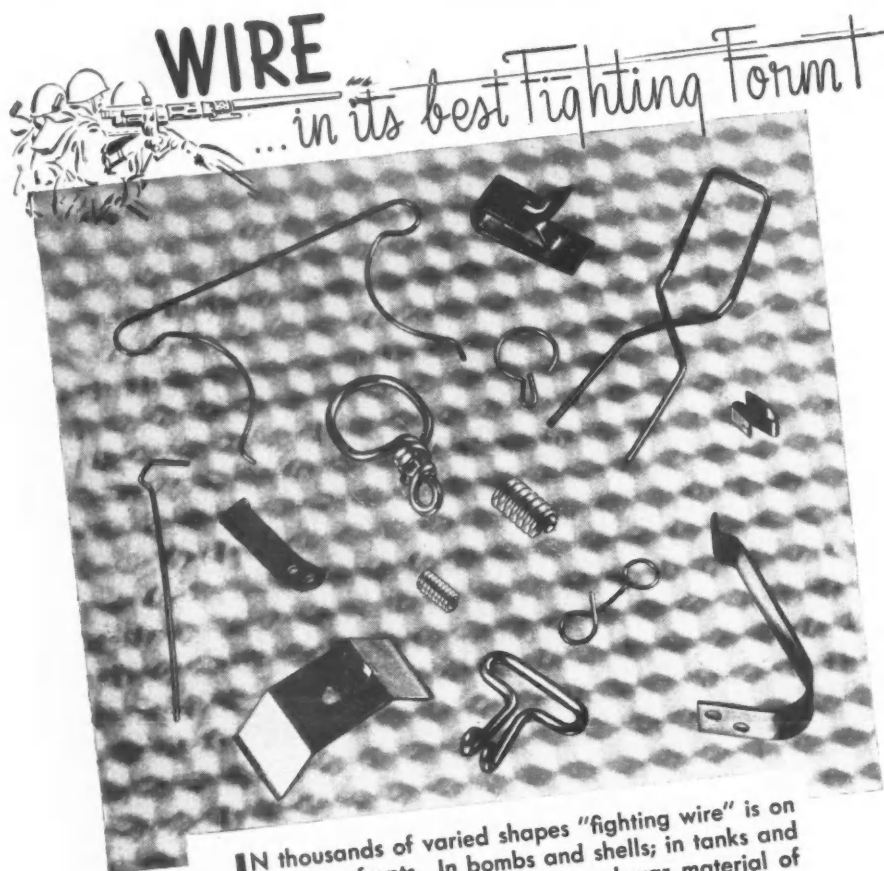
Hugh Purdy, 66, who was connected with Buck & Hickman, Ltd., agents in England for Pratt & Whitney, died Dec. 3 in England. Mr. Purdy served his apprenticeship at Pratt & Whitney in Hartford, Conn., starting Feb. 21, 1893. He worked at the Hartford plant until 1900, when he was sent abroad to join Mr. Pratt at the Paris Exposition. He remained to travel all over Europe as a Pratt & Whitney representative. Eventually Mr. Purdy established himself with Buck & Hickman and maintained this connection until his death.

David S. Youngholm, 53, who was vice-president of the Westinghouse Electric & Manufacturing Company, in charge of the company's Lamp Division, Bloomfield, N. J., died recently from a sudden heart attack. Since October, 1937, Mr. Youngholm had been a director and vice-president of the Bryant Electric Company, Bridgeport, Conn. He also was a director of the Westinghouse Electric Supply Company.

Changes of Address

Pump Engineering Service Corporation advises that the address of PESCO administrative, sales and accounting offices becomes 11610 Euclid Avenue, Cleveland, Ohio. PESCO purchasing, production and engineering departments remain at 12910 Taft Avenue, Cleveland, Ohio.

Micromatic Hone Corporation requests that all its mail be addressed to its new plant, located at 8100 Schoolcraft Avenue, Detroit, Mich.



IN thousands of varied shapes "fighting wire" is on the war fronts. In bombs and shells; in tanks and guns and planes; in equipment and war material of many types, you'll find wireforms and springs doing a thousand-and-one vital jobs.

Above, you see a few of the many Accurate-made special wire shapes which are parts of fighting implements. They're produced in huge quantities to Accurate precision standards — under rigid control from raw materials to inspected finished products.

Accurate "know-how", based on experience and specialization, can help you solve your production problems that involve springs and wireforms. Tell us what you need and when you need it—it's as simple as that.

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WIREFORMS
DO YOU
NEED?**

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Springs**

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